Gross Metabolic Changes Characteristic of the Activity of the Neonate

T. W. Richards

THE recent experimental interest in the subject of infant activity, notably by the students of Weiss at Ohio State University and latterly of Irwin at the State University of Iowa, has been confined largely to stimulus-response relationships. Pratt, Nelson, and Sun (22) investigated differentials of bodily activity in response to several stimuli, and Pratt (20, 21), Weiss (32), Stubbs (28), and Smith (27) have extended this work by way of refinement.

The study of the nature of the bodily activity of infants irrespective of specific external stimulus sources was the task of Irwin, who gave objective data regarding variations under relatively controlled conditions, originally with four infants during the first ten days (4) and later with newborns during one interval between feedings (5). The importance of time since feeding as a factor inducing bodily activity was demonstrated in these experiments. Pratt (18) obtained a very low correlation between the activity of the infant and temperature within the cabinet. Irwin (5, 6, 7) was able to show also that weight and several length and cephalic measurements of newborn infants at birth were unrelated to amount of activity shown on the stabilimeter, as were certain indices of nutritional status, body surface, and intestinal surface.

Certain studies of newborn infants in the field of metabolism wherein objective measurement of bodily activity has been made have provided a means of determining the relationship of other factors to bodily activity under fairly controlled external environment. It is the purpose of this paper to present certain reinterpretations of these data in so far as they may be pertinent to the study of bodily activity of newborn infants and its physiological concomitants.

That muscular activity is an important factor in heat production was recognized by the earliest workers in the field of metabolism. Rubner and Heubner (25, 26) emphasized its importance, and the classic work of Benedict and Talbot (1, 2) with infants took this factor into account. The conditions necessary for studies of basal metabolism of absolute rest and of fasting are, of course, impossible to control in the infant. Thus an indicator of relatively basal conditions of bodily activity was necessary.

Benedict and Talbot designed for this purpose a bed, the movements of which were transmitted to a kymograph and recorded objectively. Unfortunately they did not report the

amount of this activity together with their other physiological criteria for their 105 newborn infants (2), and a precise estimate of interrelationships with activity is impossible. They confirmed the findings of Rubner and Heubner that bodily activity raises heat production.

The most violent activity of the newborn infant, hard crying, may cause according to Benedict and Talbot an increase of 100 per cent in heat production. Extreme crying may raise it as high as 200 per cent above basal value. Murlin, Conklin, and Marsh (15) have calculated that the increase in metabolism incident to hard crying is roughly in proportion to the time spent in crying. Thus 1 per cent of the time spent in crying will induce a rise of 1 per cent in total metabolism, etc.

Benedict and Talbot believed pulse rate to correlate highly with bodily activity and with heat production. However, Murlin, Conklin, and Marsh, correlating pulse rate and heat production during basal periods for the infants of Benedict and Talbot, reported a coefficient of .276 ± .0043, and for their fifty infants a coefficient of .178 ± .0673. The coefficient for all periods for the Murlin, Conklin, and Marsh data was .374 ± .0372. It is thus not at all certain that pulse rate varies with heat production.

Both Benedict and Talbot and Murlin, Conklin, and Marsh measured body temperature and respiratory exchange in addition to heat production, bodily activity, and pulse rate. Murlin, Conklin, and Marsh used a bed recorder for measurement of bodily activity similar to that used by Benedict and Talbot. From the results of their study concerning all these indices we have taken the liberty of calculating the relation with heat production, using the Pearson coefficient. The results are as follows:

Items correlated	*r*	*P.E.*
Heat production* with pulse rate	.40	±.04
Heat production with respiratory quotient	.02	±.05
Heat production with body temperature	.14	±.05

* Heat production determined as calories per square meter body surface per hour; body surface determined according to Lissauer (14) formula:

$S = 10.3^3 W^2$, where S = surface in sq. cm. W = weight in grams, and 10.3 is constant.

Since these authors, like Benedict and Talbot, judged their activity records according to a point scale, activity was classified as basal, fretting, slightly restless, restless, and crying. For purposes of correlation we have calculated from these data, using the Yule formula, coefficients of contingency between activity on the one hand and heat production, body temperature, pulse, and respiratory quotient on the others. It should be kept in mind that the coefficients here are not strictly comparable to Pearson coefficients. They are as follows:

Items correlated	*r*
Bodily activity with pulse rate	.390
Bodily activity with body temperature	.433
Bodily activity with calories, square meter, hour	.455
Bodily activity with respiratory quotient	.281

From these coefficients it will be noted that bodily activity does not appear

to correlate highly with any other of these physiological indices.

Body temperature was found by Eckstein and Paffrath (3) to have no relationship to bodily activity, although they present no index of degree of correlation. Using a pneumatic system for recording bodily activity, they estimated activity from these records according to a point scale for hour periods. Irwin (6) found that body temperature (rectal, taken preceding the experimental period) correlated with oscillations per minute of the stabilimeter[1] gave a coefficient of $-.02$, while the temperature at birth gave a coefficient of .06, both insignificant. The degree of relationship (.433) calculated by us from the data of Murlin, Conklin, and Marsh would indicate some relationship. However, it should be kept in mind that in that study bodily activity was judged as being of one of five types for the whole experimental period and not measured per minute as in Irwin's experiments, so that fine variations are not considered.

These data regarding the relationship between body temperature and activity are of interest in connection with the physiology of temperature regulation. It has been generally accepted that bodily activity under conditions of low body temperature may in part be a reflex effect in an attempt to regulate body heat. To test this explanation one need only regard those cases in which body temperature is low and determine the extent to which bodily activity is greater than at other levels.

The average bodily activity in Irwin's (6) group of sixty-six infants, expressed in oscillations per minute of the stabilimeter, was 30. Three infants gave rectal temperatures of less than 98°F. preceding observation, as follows:

INFANT	RECTAL TEMPERATURE	OSCILLATIONS PER MINUTE
39	97.8	13.8
61	96.0	32.6
66	97.4	24.6
Mean.....	97.1	23.7

The infant with the lowest temperature was about as active as the average for the whole group, but the other two infants and the average of all three subthermic infants were below the average for the group in bodily activity. That these data do not bear out the theory that infants may respond to subnormal temperature by greatly increased bodily activity might be explained by assuming (1) that low bodily temperature is not always an index of low thermic stimulation to the infant and (2) that the lowest temperatures in this group may not be sufficiently low to elicit the regulatory response in the young infant.

Pratt (18) found a correlation between general activity as measured by the stabilimeter and temperatures of the experimental cabinet (ranging from 74° to 88°) of $-.205 \pm .024$.

Although these experiments do not show relationship between temperature and bodily activity, it is nevertheless entirely possible that a group of infants under conditions of low temperature might in some cases respond by increased activity. The point deserves experimental attack.

[1] The stabilimeter recorded movements of a bed mechanically.

Jundell (9) showed that the curve of body temperature for infants is extremely irregular, but that by the age of two to five years it has assumed the diphasic character of that for the adult. It is in this way similar to the tendency for sleep and for bodily activity to evolve from daily polyphasia in the infant to diphasia in the adult, as shown by Szymanski (29). Thus, though temperature may not vary minutely with activity of the infant, its gross variations are physiologically related to those of activity over long periods.

differences between the amounts of each of the variables which occur during conditions of basal activity and crying. The results follow:

ACTIVITY	CALORIES, SQUARE METER,* HOUR	MEAN PULSE RATE	RESPIRATORY QUOTIENT
Basal	30.0	117.1	0.83
Crying	36.3	121.1	0.82
Difference	6.3	4.0	0.01
Critical ratio	7.9	2.2	1.00

* Lissauer formula.

TABLE 1

Percentages of group of Murlin, Conklin, and Marsh (15) in each activity classification, and the means and standard deviations for each in heat production, pulse, and respiratory quotient

ACTIVITY	CASES	PER CENT	CALORIES, SQUARE METER,* HOUR		PULSE		RESPIRATORY QUOTIENT	
			Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Basal	99	42.5	30.0	4.0	117.1	11.6	.83	.09
Fretting	13	5.6	30.3	5.6	124.5	7.6	.75	.06
Slightly restless	3	1.3	30.7	6.5	135.0	11.3	.84	.12
Restless	26	11.2	31.0	4.4	124.6	10.7	.78	.05
Crying	233	100.0	32.5	6.0	121.7	12.6		

* Lissauer formula.

In order to analyze further the relationship between bodily activity and the variables studied by Murlin, Conklin, and Marsh, we have determined the means and standard deviations in pulse rate, heat production, and respiratory quotient for each of the five types of bodily activity. These data are presented in table 1.

As a further check on the differences indicated by the mean heat, respiratory quotients, and pulse rates for these groups of newborn infants, we have also calculated the significance of

Pulse rate appears to be suggestively higher during crying than when the infant is at rest. The respiratory quotient does not appear to change appreciably, but heat production increases decidedly over that under basal conditions when crying takes place. This difference is so marked that we have calculated the departure of these minimum values from the means of each of the other groups of activity. The maximum value of 36.3 calories per square meter per hour is significantly higher than those at each of the

other levels of activity. However, the levels of activity at basal, fretting, slightly restless, and restless differ significantly from each other.

A further examination of differences between the activity groups on the basis of respiratory quotient showed that the values of .82 given during basal conditions and of .83 given during crying are significantly higher than the quotients of .75 given during "fretting" and of .78 given during "restlessness." This fact is difficult to explain.

It should be kept in mind that the data of Murlin, Conklin, and Marsh discussed above are representative of all periods, irrespective of infant, time, or relation to other periods. If we select from the group those infants studied in two consecutive periods who showed a basal period followed by or following either another basal period or a period of activity, the following small groups are obtained:

Thirty-one infants gave two consecutive basal periods;
Eight infants gave a basal followed by a crying period;
Seven infants gave a crying followed by a basal period;
Three infants gave a fretting followed by a basal period;
One infant each gave basal followed by slightly restless and restless followed by basal period.

Turning our attention only to the three first named groups, since there are so few in the other groups, we obtain the following results in terms of the differences in heat production during consecutive periods expressed in per cent of basal heat production:

PERIODS	MEAN CHANGE	PER CENT	
		Maximum	Minimum
Basal–crying.....	+15.1	+51.9	0.0
Crying–basal.....	−24.6	−39.6	−17.5

Since the first observation period, starting about one-half hour after feeding, might show the effect of the specific dynamic action of foodstuffs, it is important to note the differences in heat production in two consecutive basal periods. If we consider these data as percentages at the original basal period we obtain a mean change in the second period of −4.3, with a maximum of +25.2 and a minimum of −45.4. However, if we consider the data as percentages of the period of lower heat production, there is an average drop in the second period of −6.3 per cent, with a maximum of +25.2 and a minimum of −83.1. Thus, in the second of two basal activity periods, heat production drops some 5 per cent, so that if we attempt to correct the differences between basal to crying periods and crying to basal periods we increase the former difference from 15.1 per cent to about 20 per cent and reduce the drop from crying to basal periods from 24.6 per cent to about 20 per cent. Normally, crying seems to induce an increase of about 20 per cent of the heat production during basal periods when other factors are fairly controlled. It is interesting to note, however, that the average change during basal periods, when the direction of change is ignored, is an average of 9.5 per cent of the original heat production or 11.6 per cent of the lower heat production.

It is unfortunate that we are unable satisfactorily to determine the relationship between the metabolic factors of heat production and respiratory quotient with respect to time since feeding. Many factors tend to confuse clear-cut results in this respect. Levine, Wilson, and their coworkers (12, 13) have shown that by means of the specific dynamic action of foodstuffs basal metabolism may be raised by milk diet 4 to 9 per cent, by fat 1 to 8 per cent, by protein 15 to 17 per cent, and by glucose 8 per cent in normal infants three to four months of age.

Another factor which prevents clear-cut deductions of variations in heat production with time since previous feeding is that sleep, which is characterized by definitely lowered heat production, may occur at practically any time with respect to feeding and by most observers is noted particularly immediately after feeding.

Talbot (30) has published results obtained from two infants, aged three and six months, observed for practically all of the twenty-four hour period. His results for respiratory quotient, pulse, and Gr. CO_2/Kg./Hr. are plotted in figure 1. Feeding periods are indicated by perpendiculars bisecting the curves at various intervals. It will be observed that the respiratory quotient with these two infants tends to drop during the period between feedings. Pulse rate seems slightly to increase, particularly during the longer periods, while CO_2 expired seemed to vary relatively independently of time since feeding. It will be seen that, with the exception of the pulse rate of the six months infant during the period from 7 P.M. to 6 A.M., both pulse and CO_2 expired seem to be greatest in active periods as indicated in figure 1. If these results with two infants mean anything for comparison with the newborn, it might be concluded that pulse and CO_2 expiration may vary with time since feeding. This increase in activity is not as yet clearly demonstrated in heat production nor in respiratory quotient, due to factors of sleep and "specific dynamic action" of foods.

Lesne and Nattan-Larrier (10, 11), using the apparatus of Plantefol (17), have recently reported data on CO_2 output of infants for hourly intervals after feeding. Mean values of L. CO_2/Kg. B.W./Hr. were as follows:

Interval, hours	*Mean*
½ to 1½	.50*
1½ to 2½	.49
2½ to 3½	.48

* The mean deviation from the mean of these values is reported to be about 5 per cent.

From this and other work on the relationships of metabolic factors to bodily activity on the one hand and to time since previous feeding on the other, it seems fair to conclude that among these metabolic variables there is no one index of physiological activity which corresponds at all times to muscular activity as measured by the stabilimeter. Muscular activity is a factor in raising heat production over the basal requirement, but other factors are also important. The specific dynamic action of foodstuffs is sufficient to raise heat production by a sizeable amount. Sleep, which is reported by many investigators to be

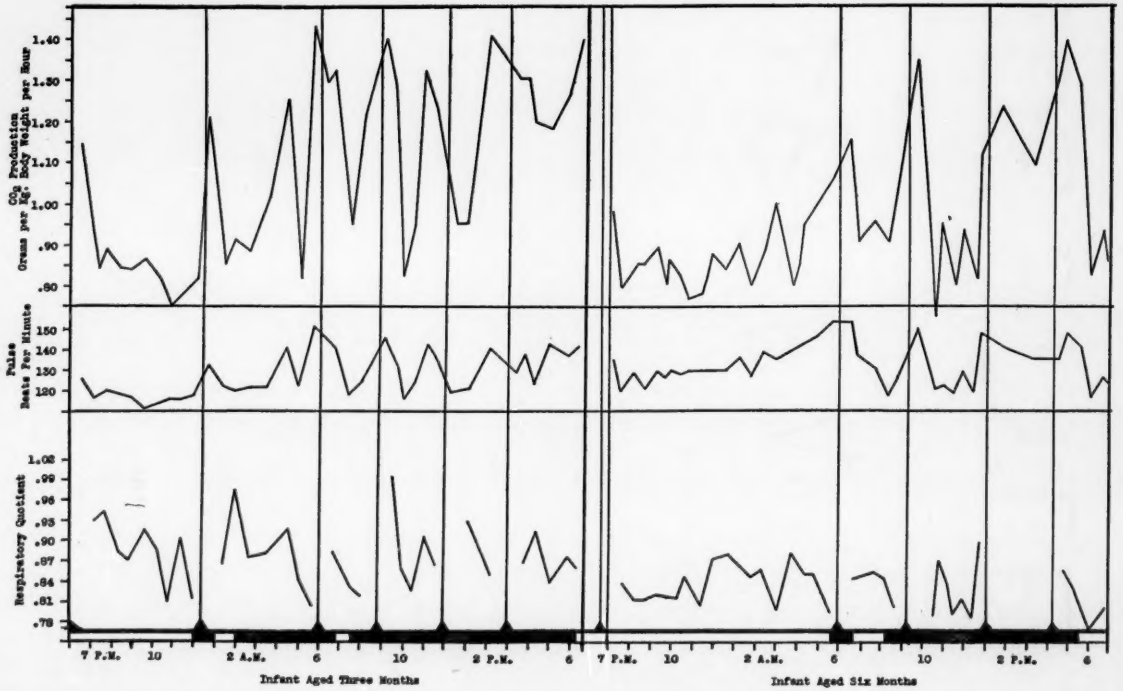


FIGURE 1. DIAGRAM ILLUSTRATING CO_2 PRODUCTION, PULSE RATE, AND RESPIRATORY QUOTIENT OF TWO INFANTS OVER A TWENTY-FOUR HOUR PERIOD

Meal periods indicated by perpendiculars erected from triangle. On base line: Solid indicates periods of "activity," cross hatch indicates "awake but quiet," and white indicates "sleep." From data of Talbot (30). Converted into Gr. CO_2/Kg. B.W./Hr. by the author.

most prominent soon after feeding, has been shown to reduce total heat production, as one would expect from the fact that in the infant what is judged as sleep is in some measure the reciprocal of muscular activity. The heat production subsequent upon growth, though important at this level, is a factor which would not greatly affect results at any one restricted age level since it should introduce a constant increase. Thus we may assume that if basal metabolism might be accurately determined at the level of the newborn infant and if heat production incidental to specific dynamic action of foods and possibly to growth were held constant (i.e. through control of feeding, difficult with breast fed infants), the degree to which heat production is increased over the basal value would correlate highly with muscular activity as indicated by the stabilimeter. A relationship might obtain between a similar ratio of increase in respiratory quotient. Here, however, not only the specific dynamic action of foodstuffs but the extent to which O_2 is required to oxidize them to end products of CO_2 and H_2O is a factor, and the ratio of fat to carbohydrate would need to be held constant. In addition, an indication of protein metabolism by measurement of urinary nitrogen would be necessary. Body temperature, excepting perhaps under extreme conditions, is not related to bodily activity.

It was mentioned early in this paper that Irwin (5) correlated the von Pirquet (16) index of intestinal surface (area of intestine = (sitting height)^2) with bodily activity, obtaining a coefficient of $-.02 \pm .08$. Regarding this finding, it might be supposed that bodily activity estimated as oscillations of the stabilimeter per unit time would not be expected to vary with intestinal surface so much as would the acceleration in bodily activity only during the early part of the past feeding period. The blood sugar curve of Winter for infants (33) shows that maximum carbohydrate has been absorbed from the intestine by sixty minutes after feeding. Thus as intestinal surface presumably affects rate of absorption, the time necessary for maximum blood sugar to appear in the blood should correlate with intestinal surface, and it would be interesting to see whether or not each of these indices would correlate, not so much with bodily activity, but with the degree of acceleration of bodily activity subsequent upon feeding.

SUMMARY

Muscular activity in the infant appears definitely to raise heat production. Although it was earlier believed that heat production varied with pulse rate to some extent, examination of data shows the degree of correlation to be but .28 during periods of inactivity, and but .37 to .40 for all periods. Pulse rate correlates slightly with muscular activity for all periods, again with a coefficient of about .40. When heat production and muscular activity for all periods are correlated, a coefficient of .46 is obtained.

Respiratory quotient appears to vary somewhat independently of both heat production and muscular activity.

Body temperature varies quite independently of heat production and

seems related slightly if at all to muscular activity. Environmental temperature seems also to be slightly related to bodily activity.

When very active (crying) infants are compared with inactive infants, a significant increase in heat production is found. This increase on occasion has been claimed to be as high as 200 per cent over basal heat production. Between consecutive periods of heat measurement on the same infants, crying may induce an average rise of 20 per cent in heat production when specific dynamic action is partialled out. A slight increase in pulse is also engendered by extreme bodily activity. No difference between crying and inactive infants is noted in respiratory quotient.

We might conclude from these data that there is at present no one index of physiological function which seems highly related to bodily activity. Muscular activity may be considered not only as an expression of the nutritional state of the organism, as pointed out elsewhere (7, 19, 23), but as a factor contributing toward total heat production of the organism. Acquaintance with more subtle physiological variables, as yet but little understood, may lead ultimately to an understanding of the organic determinants of variations in infant behavior.

REFERENCES

(1) BENEDICT, FRANCIS G., AND TALBOT, FRITZ B.: The gaseous metabolism of infants: With special reference to its relation to pulse-rate and muscular activity. Washington, D. C.: Carnegie Institution of Washington, 1914, Publ. No. 201, Pp. 168.

(2) BENEDICT, FRANCIS G., AND TALBOT, FRITZ B.: The physiology of the new-born infant: Character and amount of the katabolism. Washington, D. C.: Carnegie Institution of Washington, 1915, Publ. No. 233, Pp. 126.

(3) ECKSTEIN, A., AND PAFFRATH, H.: Bewegungstudien bei frühgeborenen und jungen Säuglingen. Zsch. f. Kinderh., 1928, **46**, 595–610.

(4) IRWIN, ORVIS C.: The amount and nature of activities of newborn infants under constant external stimulating conditions during the first ten days of life. Genet. Psychol. Monog., 1930, **8**, 1–92.

(5) IRWIN, ORVIS C.: The relation of body motility in young infants to some physical traits. J. Exper. Educ., 1932–1933, **1**, 140–143.

(6) IRWIN, ORVIS C.: Motility in young infants: I. Relation to body temperature. Amer. J. Dis. Child., 1933, **45**, 531–533.

(7) IRWIN, ORVIS C.: Motility in young infants: II. Relation to two indexes of nutritional status. Amer. J. Dis. Child., 1933, **45**, 534–537.

(8) JANET, HENRI, AND BOCHET, MADELEINE: Le métabolisme des jeunes nourrissons normaux étudié par la méthode des échanges respiratoires. Comptes Rendus Soc. de Biol., 1931, **107**, 1229–1231.

(9) JUNDELL, I.: Über die nykthemeralen Temperaturschwankungen im ersten Lebensjahre des Menschen. Jahrb. f. Kinderh., 1904, **59**, 521–619.

(10) LESNÉ, E., AND NATTAN-LARRIER, R.: Sur la notion de métabolisme basal du nourrisson. Comptes Rendus Soc. de Biol., 1934, **115**, 802–804.

(11) LESNÉ, E., AND NATTAN-LARRIER, R.: Exposé et critique des résultats obtenus dans l'étude du métabolisme respiratoire des nourrissons. Comptes Rendus Soc. de Biol., 1934, **115**, 804–806.

(12) LEVINE, SAMUEL Z., WILSON, JAMES R., BERLINER, FRIEDA, AND RIVKIN, HELEN: The respiratory metabolism in infancy and in childhood: VI. The specific dynamic action of food in normal infants. Amer. J. Dis. Child., 1927, **33**, 722–731.

(13) LEVINE, SAMUEL Z., WILSON, JAMES R., AND GOTTSCHALL, GERTRUDE: The respiratory metabolism in infancy and in childhood: X. The respiratory exchange in marasmus: Specific dynamic action of food in normal and in marasmic infants. Amer. J. Dis. Child., 1928, **36**, 740–755.

(14) LISSAUER, W.: Ueber Oberflächenmessungen an Säuglingen und ihre Bedeutung für den Nahrungsbedarf. Jahrb. f. Kinderh., 1903, **58**, 392–411.

(15) MURLIN, JOHN R., CONKLIN, RUTH E., AND MARSH, M. ELIZABETH: Energy metabolism of normal newborn babies: With special reference to the influence of food and of crying. Amer. J. Dis. Child., 1925, **29**, 1–28.

(16) VON PIRQUET, C. F.: Ernährung nach der Darnfläche. Zsch. f. Kinderh., 1917, **15**, 100–116.

(17) PLANTEFOL, L.: Sur un appareil destiné a l'étude des échanges respiratoires et en particulier de ceux des nourrissons. Comptes Rendus Soc. de Biol., 1933, **113**, 665–668.

(18) PRATT, KARL C.: Note on the relation of temperature and humidity to the activity of young infants. Ped. Sem. & J. Genet. Psychol., 1930, **38**, 480–484.

(19) PRATT, KARL C.: The neonate. [In] MURCHISON, CARL [editor]: A Handbook of Child Psychology. 2nd ed. rev. Worcester, Mass.: Clark University Press, 1933. Pp. xii, 956. (p. 163–208).

(20) PRATT, KARL C.: The effects of repeated auditory stimulation upon the general activity of newborn infants. Ped. Sem. & J. Genet. Psychol., 1934, **44**, 96–116.

(21) PRATT, KARL C.: The effects of repeated visual stimulation upon the activity of newborn infants. Ped. Sem. & J. Genet. Psychol., 1934, **44**, 117–126.

(22) PRATT, KARL CHAPMAN, NELSON, AMALIE KRAUSHAAR, AND SUN, KUO: The behavior of newborn infants. Columbus, Ohio: Ohio State University Press, 1930. Pp. xiii, 237.

(23) RICHARDS, T. W.: The importance of hunger in the bodily activity of the neonate. Unpublished manuscript.

(24) RUBNER, MAX, UND HEUBNER, OTTO: Die natürliche Ernährung eines Säuglings. Zsch. f. Biol., 1898, **36**, 1–55.

(25) RUBNER, MAX, UND HEUBNER, OTTO: Die künstliche Ernährung eines normalen und eines atrophischen Säuglings. Zsch. f. Biol., 1899, **38**, 315–398.

(26) SCHLOSSMANN, A., AND MURSCHHAUSER, H.: Gasstoffwechseluntersuchungen bei Neugeborenen und Frühgeborenen. Zsch. f. Kinderh., 1932–1933, **54**, 301–316.

(27) SMITH, JOSEPHINE M.: The relative brightness values of three hues for newborn infants. [In] Studies in Infant Behavior III, Univ. Iowa Stud., Stud. in Child Welfare, 1935, (in press).

(28) STUBBS, ESTHER M.: The effect of the factors of duration, intensity, and pitch of sound stimuli on the responses of newborn infants. [In] Irwin, Orvis C., Weiss, LaBerta A., and Stubbs, Esther M.: Studies in Infant Behavior I. Univ. Iowa Stud., Stud. in Child Welfare, 1934, **9**, No. 4, Pp. 175. (p. 75–135).

(29) SZYMANSKI, J. S.: Versuche über Aktivität und Ruhe bei Säuglingen. Pflügers Arch. f. d. ges. Physiol., 1918, **172**, 424–429.

(30) TALBOT, FRITZ B.: Twenty-four-hour metabolism of two normal infants with special reference to the total energy requirements of infants. Amer. J. Dis. Child., 1917, **14**, 25–33.

(31) TALBOT, FRITZ B.: Basal metabolism of children. Physiol. Rev., 1925, **5**, 477–517.

(32) WEISS, LABERTA A.: Differential variations in the amount of activity of newborn infants under continuous light and sound stimulation. [In] Irwin, Orvis C., Weiss, LaBerta A., and Stubbs, Esther M.: Studies in Infant Behavior I. Univ. Iowa Stud., Stud. in Child Welfare, 1934, **9**, No. 4, Pp. 175. (p. 9–74).

(33) WINTER, EGON WERNER: Studien über den Kohlehydratstoffwechsel. I. Mitteilung: Beitrag zur Kenntnis des Kohlehydratsoffwechsels beim Neugeborenen. Arch. f. Gynaekol., 1933, **154**, 354–373.

Laterality of Function in Early Infancy under Controlled Developmental Conditions[1]

WAYNE DENNIS

INTRODUCTION

WHILE the data on handedness are now extensive, the facts concerning this phenomenon in the period of early infancy are still meager. The need of a larger number of developmental studies such as the ones conducted by Baldwin and Woolley (1, 20) is quite apparent.

I have recently reported an experiment upon the effect of restricted social stimulation and of restricted practice upon the behavioral development of two infants. At an early period in the conduct of this study it was decided to incorporate as a part of the experimental routine some precautions against differential treatment of the two sides of the body. These provisions made it possible to obtain another record of handedness and of related aspects of behavior under controlled developmental conditions.

SUBJECTS AND PROCEDURE

The subjects of the investigation were non-identical female twins which were reared under a controlled regimen from the 36th to the 428th day of life. Mrs. Dennis and I assumed their entire care. The general routine of procedure has been described elsewhere (5, 6) and it is necessary here to describe only the precautions which, beginning on day 48, were taken to prevent favoritism of either side of the body on our part.

The infants spent almost their entire time in two Kiddie Koops, 40¼ inches long, 24½ inches wide, and 20 inches deep, which were placed side by side but which were separated by an opaque screen of the same height as the cribs. Because of this arrangement one crib had to be approached on the right side and the other on the left side. At an early date this led to a laterality in the behavior of the infants which will be described later, and this in turn caused us to adopt the following practices.

In order to avoid as completely as possible any unequal treatment of the two sides, beginning with day 48 each baby was alternated daily in respect to the bed which she occupied. This not only caused us to approach each infant the same number of times from either direction but it also prevented the possibility that laterality preferences might arise through either twin

[1] Acknowledgment is gratefully made to the Institute for Research in the Social Sciences at the University of Virginia for defraying the expenses of the research here reported and to Mrs. Dennis for her invaluable coöperation and assistance.

turning toward the other's crib. Furthermore, the environments of the infants were identical to the extent that the subjects spent the same amount of time in each of the two cribs.

At the beginning of the experiment each subject was fed by placing the bottle of milk upon a small pillow by her head. The subjects faced in opposite directions in nursing as shown in figure 1. On day 48, however, we began to take each subject in arms for feeding. Each baby was placed on the experimenter's lap and supported by the experimenter's left arm. The feeding bottle was held in the experimenter's right hand, but care was taken to hold the infant so that her arms would not be unequally restrained. The nursing bottle was held straight in front of the baby. When the feeding of solid foods was begun, the foods were given from a spoon which was held in the experimenter's right hand but which was advanced to the mouth from a position judged to be directly in the median line of the subject. In administering stimuli, too, and in offering toys, we again tried to avoid asymmetrical treatment of the subjects, although the experimenter's right hand was always used.

One may rightfully doubt whether unequal treatment of the two sides of the body was really avoided when care was administered in the right-handed fashion described above. However, the data to be presented have certain characteristics which it seems unlikely could have resulted from our own behavior.

The subjects were fed simultaneously, Mrs. Dennis feeding one and I feeding the other. Since it is likely that our techniques differed slightly, although unintentionally, we alternated daily in the feeding of the babies; that is on one day Mrs. Dennis fed Del and I fed Rey, on the next day Mrs. Dennis fed Rey and I fed Del, etc. In other matters, too, such as in changing diapers and in bathing, the attentiveness of each experimenter was given equally to the two subjects.

RESULTS

A head turning habit. Since no effect of the method of feeding first described above was anticipated, the earliest appearance of a turning habit may have been overlooked. The habit was first noticed on day 46, or after the babies had been fed for 10 days five to six feedings per day in the manner outlined above. On this day it was observed that each baby during a large part of the time held her head in the position which she maintained in nursing.

In order to find whether this might be due to a peculiarity of the bedding, etc., Rey was placed in crib B and Del was removed to crib A not long after the early morning feeding. Figure 2 shows the result. The original direction of the head was maintained, so that each infant turned away from the appropriate feeding point of the crib which she now occupied.

At the next feeding hour, 11 A.M. these positions were maintained even when the bottles were held in the usual places. That is, each infant turned in a direction which now caused her to face away from the bottle. The infants were sufficiently hungry that the

situation caused them to cry. The screen between the cribs ruled out the possibility that either infant was visually directed by the wrong bottle.

These positions were held so consistently that each infant had to be turned on her side toward the food and held in this position in order to get her started to eating. While nursing, each baby gradually returned to the supine position, keeping her head turned in the new direction.

The placement of babies in the cribs as indicated by figure 2 was maintained after this feeding. Unfortunately no further records of head positions were taken until the next feeding hour, 3 P.M., day 46. At that time, Del was correctly turned when the bottle was offered; Rey first turned to the wrong side as she had done four hours earlier, but was more easily corrected than she had been on the preceding occasion.

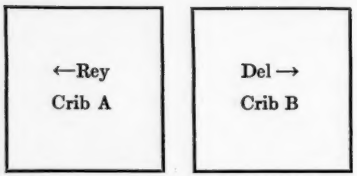


FIG. 1

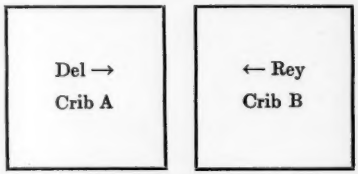


FIG. 2

The situation shown by figure 2 was retained throughout day 46, but no further errors in turning for food were seen.

Before the 11 A.M. feeding on day 47, each infant was returned to her original crib as shown in figure 1. Del immediately turned toward the bottle; Rey, however, continued to turn in the direction which had been correct the immediately preceding day, although that direction was now incorrect. When she persisted in her error and obtained no food, the nipple was placed in her mouth and the experimenter slowly pulled the bottle to the new position. The situation shown in figure 1 was maintained during day 47. At 3 P.M. of this day no error occurred with Rey, but at 7 P.M. the behavior noted at 11 A.M. was approximately duplicated. Upon both of these occasions Del's behavior was apparently controlled by the position of the bottle, as noted earlier on this day.

As we deemed it desirable to avoid the formation of habits of sidedness we began at this time to take each subject in arms for feeding, as described previously. Thus the position habit in feeding was brought to an end at this point.

Movie study. A movie study has shown that upon detailed analysis differences in activity on the two sides of the body were discernible in responses to certain stimuli which were administered between days 48 and 81, (8). The data of the movie study are too extensive to be reviewed here. The present report deals only with asymmetrical patterns of behavior which were observable without the aid of a recording device.

Nursing posture. The first pat-

terned response to show a definite asymmetry was the feeding posture. A brief report on the postures of defecation and of nursing in these subjects and in several premature and normal-term newborn infants has already been presented (4). The nursing response of each infant when she first came under observation may be described as follows: During nursing and also during the abdominal strains of defecation, the forearms were hugged tightly to the chest with the fists near the neck. The legs and toes were extended and when the infant was on her back the lower extremities were often raised slightly off of the supporting surface. The response did not occur in the feeding situation if the infant was not hungry or if she was very sleepy, and did not appear in the case of elimination if the feces were soft or watery. Up to day 70 the nursing posture as described above was recorded 157 times, distributed about equally between the two infants. The only feeding posture apart from the one just described which was seen during this period was exhibited by Rey alone and it later became her characteristic nursing posture. Within this same period 32 defecations were witnessed and in 29 of these the previously described pattern was seen. Of the remaining three instances of defecation, two occurred without associated limb movements and in the remaining case, that of Del, one forearm was extended by the side instead of being drawn up to the chin.

In accordance with the above description it is seen that the nursing posture and defecation postures were bilaterally symmetrical up to about day 70. Thereafter each infant began in connection with nursing to display a variation in the response, which made it asymmetrical.

In Rey's case the modification consisted in rigidly holding one of the forearms parallel to the mid-line of the head with the elbow straight out from the shoulder. In the third and fourth lunar months Rey did this with only one arm a total of 69 times, the other arm keeping the position indicated by the original description. She never did it with both arms in this period. In 88 per cent of the cases the arm which performed the new response was the right arm. In later months this response came to be predominantly bi-manual and hence again asymmetrical, but on the occasions on which it remained unimanual the right hand held the position in approximately the same proportion of the cases as had been the case in the earlier asymmetrical responses. After the 7th lunar month Rey's nursing posture gradually disappeared.

Del's new feeding posture consisted in extending one or both arms at her side, parallel to the body. The arm or arms were actively extended, not merely relaxed in this position. Within the first seven lunar months this new response was observed on 89 occasions, on 95 per cent of which it involved only one arm. In all but 6 cases this was the left arm. In later months Del, too, gradually ceased to keep any definite posture during feeding. Even before the appearance of asymmetry in the nursing posture was observed, the act of defecation had ceased to involve the arms in any stereotyped manner, so that laterality

could not be observed in that connection. The legs continued to extend during defecation for many months, but almost invariably this was a bilateral response.

Time sampling observations. In addition to the nursing posture, it is possible that other patterned activities such as sucking the fingers and rubbing the face involved a definite hand preference during the first six months, but our casual observations of these responses were too few to establish the point. For that reason we began in the seven lunar month a series of time-sampling studies. Following, many of the feeding periods of the 7th 8th, 9th, 10th and 11th lunar months we observed and recorded behavior systematically, noting which limbs were involved in each response. In making this observational study we sat at the foot of the cribs and about four feet from them, in a position which made us invisible to the babies. The babies lay on their backs in the cribs and were uncovered and without toys of any kind. Time was kept by a stop-watch. On each occasion upon which observations were taken, we observed for 15 seconds, recorded for 15 seconds, observed for another 15 seconds, etc., until twenty such recording periods were completed.

TABLE 1

LUNAR MONTH	RUB FACE						HAND TO MOUTH						SCRATCH SHEET, CRIB, ETC.					
	Rey			Del			Rey			Del			Rey			Del		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
7th	82	39	35	114	83	99	39	74	34	220	86	74						
8th	151	41	52	78	96	93	88	82	42	185	86	81						
9th	39	62	33	50	98	98	53	87	28	108	70	55	33	100	90	27	100	96
10th	47	64	60	60	98	98	68	91	14	184	73	50	33	100	55	39	100	33
11th				21	100	96	40	97	0	82	65	47	22	100	18			

LUNAR MONTH	ARM ACROSS FACE						SUCK HAND			WAVE LEG			FOOT RAISED AND GRASPED		
	Rey			Del			Rey			Rey			Rey		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
7th				37	100	100							65	42	41
8th				46	100	100	22	95	23	19	100	0	75	32	46
9th	48	85	95	43	91	100	32	100	0	40	100	0	181	64	45
10th	28	100	100	30	60	84	140	100	8	84	100	0	195	75	60
11th				24	80	96	43	100	0	37	100	11	113	81	53

The results with respect to side preference are shown in table 1. The table is constructed as follows: Under the heading N is shown the number of instances which were observed. The variation from month to month in N does not reveal changes in the subjects as the number of observational periods per month was not held constant. The heading "%U" shows the per cent

of instances in which the behavior was unilateral, and the heading "%R" shows the per cent of the unilateral responses, not of the total responses, which were performed by the right side of the infant. Any significant deviation of the R scores from the chance expectancy of 50 per cent indicates therefore a side preference.

Several characteristics of the data contained in the table may be mentioned. Firstly, the degree of unilaterality varied greatly among the different patterns of activity. For instance, in the case of each subject the act of scratching the screen of the crib was invariably a unimanual activity, whereas rubbing the face was often engaged in simultaneously by the two hands. With Rey, the degree of bilaterality even in the use of the legs depended upon the type of activity engaged in.

Secondly, among hand activities the side preference of Rey at certain months varied with the response. In the ninth month, Rey was left-handed in rubbing the face, and in "hand to mouth" response, but right-handed in scratching and in arm-across-face, the latter indicating sleepiness. She later became left-handed in scratching but never became left-handed in hand-across-face behavior. Del was somewhat more consistent in hand-preference, preferring her right hand in most activities, but she used right and left hands about equally often in putting fingers to her mouth. It will be recalled that Del's left hand was the first to change its rôle in the nursing posture.

Thirdly, the records of the two subjects are different in two respects. The infants had opposite preferences in respect to rubbing the face. With reference to hand-to-mouth, Rey showed a pronounced left preference and Del exhibited scarcely any preference at all. In the other two activities shown here their records are somewhat similar. It will be noted that Rey engaged in three activities which were practiced so seldom by Del that her record is not included in the table. The differences between the two subjects seems to show that the preferences were not unwittingly imposed by us through our care, for had the preferences been forced upon the infants it seems unlikely that the two subjects would have differed.

Reaching. Between the 11th and 15th lunar months we conducted a number of reaching tests with a dangling ring, a rattle, and the nursing bottle. The dangling ring was held within easy reach directly in the median plane as the baby lay in her crib. The ring was removed from her hand soon after she grasped it, and another test was made almost immediately. Usually about ten such tests were made at one "sitting." The tests became somewhat of a game and the babies did not object to the removal of the ring.

The rattle was presented in a similar fashion except that the infant was placed in a high-chair for the test and the rattle was put on the tray of the chair in the median plane of the subject and within easy reach.

Tests with the nursing bottle were made at the routine feeding times, the nipple being withdrawn from the mouth and held directly in the median plane of the infant and within easy

reach until she replaced it by her own efforts. Not more than five tests were made at one feeding.

The results of these tests are shown in table 2, which is constructed in the same manner as table 1.

The table shows that these responses were predominantly unimanual. In Del's case, they were almost exclusively so. The unimanual actions of Del in these situations were carried out by the right-hand in 100 per cent of the cases, in a total of roughly 500 tests.

Rey at the start was left-handed in reaching for bottle and rattle and by these tables because the data are grouped by months. A great many trials with the dangling ring were given on day 351 and a large number of tests with the rattle were made on day 358 in violation of the usual rule of administering no more than 10 tests at a time. On the former day she reached 24 consecutive times with her right hand, then 8 consecutive times with her left, 9 more with her right, 3 with her left, and finally 6 with her right. On the latter day she reached 18 consecutive times with her left and then 8 consecutive times with her right. It goes without saying that the

TABLE 2

LUNAR MONTH	GRASP DANGLING RING						GRASP BOTTLE						GRASP RATTLE					
	Rey			Del			Rey			Del			Rey			Del		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
11th	90	90	53	92	95	100	54	100	0	64	94	100						
13th	70	98	71	25	100	100	101	92	4	107	100	100	46	100	20	58	100	100
14th							22	100	0	25	100	100						
15th							240	94	82	148	100	100	54	100	72	37	100	100

ambidextrous in grasping the ring but she changed in the direction of greater preferences for her right hand in all of the activities during the course of the experiments. However, the changes in hand preference in different activities did not occur at the same time. During the 13th month she was somewhat right-handed in reaching for the dangling ring but she was still pronouncedly left-handed in reaching for the bottle and the rattle. In no situation did she ever use either hand to the total exclusion of the other as did Del.

Rey underwent temporary changes in handedness which are not revealed probability that divisions of this sort occurred through chance is extremely small. Franz (10) has reported somewhat similar shifts in handedness in monkeys.

Restraining the preferred hand. Because Del had never used her left hand in the reaching tests though she did use her left arm on other occasions, we tested her with the nursing bottle on day 408 with her right hand enclosed inside the sleeping garment, a Dr. Denton garment, which she wore at the time. The right arm was withdrawn from the sleeve and the garment was buttoned over the arm. This gave her arm some freedom but it was

impossible for her to reach the bottle with it.

On the first trial she attempted to reach with her right hand as usual and when she failed she cried. She tried to reach the nipple by bending her head forward, but did not make any effort with her left hand. After she had cried for a minute the nipple was placed in her mouth to quiet her.

After about 30 seconds the nipple was again withdrawn and was held in the position which it usually occupied during the tests. She repeated her first performance with respect to trying to reach with her right hand, trying with her mouth, and then crying. She finally grasped the nipple with her left hand, though she usually grasped the bottle, not the nipple, but did not pull it toward her mouth. Again the bottle was given to her.

On the third trial she attempted to reach with her left hand almost immediately but did not succeed in grasping the bottle in 30 seconds of effort.

This striking deficiency of the unpracticed hand, showing as it did a very imperfect cross-transfer, deserved further study but unfortunately the final three weeks of the experiment called for so many other observations and tests that the proficiency of Del's left hand was not pursued further. When she was given an opportunity to reach with her right hand at the next nursing period, she immediately resumed her use of this hand.

Other preferences in the fourteenth and fifteenth months. During the last months of the experiment, Rey was not consistently right-handed even though she preferred her right hand at this time in all of the responses which occur in table 2. She used her right arm in raising herself to a sitting position in 57 of 58 instances which we observed in the 15th month, and her right hand held her foot in all of 23 records of this response. However, it was the *left* foot which was held in 19 of these instances, and it was her *left* thumb which was in her mouth in all of the 24 cases of thumb sucking which were recorded in the fifteenth month.

Del, on the other hand, was still consistently right-handed in practically all of her activities which came under our notice. These actions were: pushing the bottle away when she had finished eating, 51 cases, all R; fingering her lips in sound play, 38 cases, all R; patting herself on the chin, 38 cases, all R; rising to sitting by pushing with her arm, 94 cases, all R; and putting her foot on the tray of her high-chair, 17 cases, all R. She rolled from her back to her abdomen with roughly the same frequency by way of either side in a total of 53 cases, although in going from supine to prone she always turned on her right side, 42 cases.

DISCUSSION

1. It may be noted first that the incidental observation of a head turning habit which led us to be especially careful in our care of the infants shows that asymmetry of function may at a very early age be the result of the manner in which the adult cares for the infant. There seems to be no doubt that the head turning phenomenon was a true habit and that it was due to the manner in which the babies

were fed. However, it quickly disappeared under appropriate procedure.

2. On the other hand the data show that pronounced laterality preferences may develop when precautions are taken to avoid training that favors either side. Handedness need not be conceived of as a mere tradition or a "culture trait." This study agrees with the investigations of Baldwin (1) and of Wooley (20). Each of these authors found that handedness appeared in a child which was reared with the intention on the part of the parents to avoid influences prejudicial to either hand. There is, of course, the question as to whether the investigators succeeded in carrying out their intentions. In the present instance the differences which appeared between the two subjects tend to indicate that there was no general imposition of handedness by the experimenters.

3. The data here presented show that high dextrality and sinistrality are possible at an early age. Studies by Jones (13) and others (14, 17) show that dextrality increases with age when the records of a few tests on each of a large number of children are totalled. These studies do not reveal with much reliability the condition of any individual child because only a few tests were administered to any one subject. That individual cases may be very unlike the general trends is suggested by the fact that both Del and Rey were almost 100 per cent dextral in many activities from seven months of age onward, and possibly even at an earlier age.

4. The change in handedness in certain activities which Rey underwent is a common but not a universal phenomenon. It is recorded in the biographical studies of Wooley (20), Darwin (2), Major (15), G. Stanley Hall (11), Myers (16) and Dearborn (3) and doubtless in still other accounts as well. Needless to say, Rey's changes were not accompanied by any disturbances of vocalization in so far as we could observe, and some of the writers referred to above also call attention to the fact that spontaneous changes in handedness produce no effect upon the language mechanism.

5. *Specificity of Handedness.* In respect to theories of handedness, the most important aspect of the present study is the proof of the specificity of early laterality preferences, which is abundantly provided by the data which have just been presented. Explanations of handedness have usually assumed that handedness is a general trait. In light of the data summarized by Downey (9) in her review of laterality of function it now seems that these explanations are in the embarrassing situation of having explained "facts" which do not exist. For there is a wealth of material to show that hand preference is dependent upon the action which is performed and upon the situation in which it is performed.

But the advocates of a simple theory of handedness, such as the "dominant hemisphere" theory, can suppose that while handedness is *natively* a general trait the demands of civilization may cause a man to write with one hand but to throw baseballs with the other. These advocates, however, will find it extremely difficult to account for a specificity of handedness such as occurred in both subjects of the present investigation on the basis of social

interference with a native general handedness.

The data on the twins do not stand alone. Baldwin found his daughter to be ambidextrous in reaching for near objects but right-handed in executing long reaches. Wooley noted with reference to her child that at an age at which he reached predominantly with his right hand, he preferred his left-hand in waving bye-bye. Valentine (18) reported that left-handedness in reaching for wools was not accompanied by a similar preference in other activities in his subject, for his son used the right hand exclusively in thumping the piano at the time of Valentine's study.

One may be able to bolster up the theory of a general hand preference in the above cases by supposing that the non-preferred hand was used in some activities because the preferred hand was reserved for possible concomitant actions which were more dominant. Whether this is the true explanation might be put to an experimental test. Meanwhile it seems advisable to call to the attention of theorists the possibility that handedness may be specific from the beginning. Is there anything absurd in the notion that the bones, muscles, tendons, joints and nerves of a particular infant may be so constructed that the right is the more suitable for the grasping of one type of object and the left for grasping another kind of material? I see no obvious absurdity in this explanation of preferences such as Rey's.

Is it also not possible that a difference in structure sufficient to cause a laterality preference in a certain activity may lie anywhere in the involved sensory-neuro-motor arc, in sense organs, in muscles, in bones, in tendons, in joints, as well as in nervous tissue? Valentine and Wagner's demonstration of handedness in the newborn (19), whose cortex is probably non-functional, shows that not all bases of preference are located in the cortex, as often seems to be assumed. In anatomical research, slight asymmetry of structure is found in all parts of the body, not merely in the cortex. This fact suggests that a single-cause explanation of handedness is an unreasonable one from the start.

SUMMARY

This report has dealt with the laterality aspects of the behavior of two infants who, to the best of the experimenter's ability, were guarded from an early age from incidents which might be expected to lead to a side preference in any activity. It has been shown that laterality preferences developed, nevertheless, and that they were often unlike in the two infants. It seems necessary to conclude that they were not socially transmitted. Further it has been pointed out that the study shows the possibility of a very high degree of dextrality from the seventh month onward. Nevertheless, dependence of laterality preferences upon the situation and upon the particular response characterized the data of the entire study. From this fact, and from other considerations, it is suggested that the assumption that handedness is a general trait and the assumption that hand preferences are due solely to asymmetrical structure of the cortex are unjustified and that a single cause explanation of all

hand preferences is unlikely to be correct. The preceding statement is in terms of *manual* laterality because discussions and researches have so often stressed the handedness aspects of asymmetrical function, but the argument is meant to apply to other kinds of sidedness as well.

REFERENCES

(1) BALDWIN, J. M.: The origin of right-handedness. Pop. Sci. Mo., 1894, **44**, 606–615.

(2) DARWIN, C.: A biographical sketch of an infant. Mind, 1877, 2, 285–294. Reprinted in Pop. Sci. Mo., 1900, **58**, 197–205.

(3) DEARBORN, G. V. N.: Moto-sensory development; Observations on the first three years of childhood, Baltimore. Warwick and York, 1910. Pp. 215.

(4) DENNIS, W.: Two new responses of infants. Child Dev., 1932, **3**, 362–363.

(5) DENNIS, W.: The effect of restricted practice upon the reaching, sitting and standing of two infants, J. Genet. Psychol., 1935, **47**, 17–32.

(6) DENNIS, W.: An experimental test of two theories of social smiling in infants. J. Soc. Psychol., 1935, **6**, 214–223.

(7) DENNIS, W.: A bibliography of baby biographies. Child Dev. In press.

(8) DENNIS, W.: An analysis of movie records of the responses of two infants. (In preparation.)

(9) DOWNEY, J.: Laterality of function. Psychol. Bull., 1933, **30**, 109–142.

(10) FRANZ, S. I.: Observations on the preferential use of the right and left hands by monkeys. J. Anim. Behav., 1913, **3**, 140–144.

(11) HALL, G. S.: Notes on the study of infants. Ped. Sem., 1891, **1**, 127–138.

(12) HEINLEIN, J. H.: A study of dextrality in children. J. Genet. Psychol., 1929, **36**, 91–119.

(13) JONES, H. E.: Dextrality as a function of age. J. Exper. Psychol., 1931, **14**, 125–143.

(14) LIPPMAN, H. S.: Certain behavior responses in early infancy. Ped. Sem., 1927, **34**, 424–440.

(15) MAJOR, D. R.: First steps in mental growth. New York, Macmillan, 1906. Pp. 360.

(16) MYERS, C. S.: Some observations on the development of the color sense. Brit. J. Psychol., 1908, **2**, 353–363.

(17) UPDEGRAFF, R.: Preferential handedness in young children. J. Exper. Educ., 1932, **1**, 134–139.

(18) VALENTINE, C. W.: The colour perception and colour preferences of an infant during its fourth and eighth months. Brit. J. Psychol., 1914, **6**, 363–387.

(19) VALENTINE, W. L., AND WAGNER, I.: Relative arm motility in the newborn infant. Studies in Infant Behavior. Ohio State Univ. Press, 1934, pp. 53–68.

(20) WOOLEY, H. T.: The development of right-handedness in a normal subject. Psychol. Rev., 1910, **17**, 34–41.

The Movement Response of the Human Fetus to Sound Stimuli

LESTER WARREN SONTAG AND ROBERT F. WALLACE

IN a preliminary report of their work on human fetal behavior, Sontag and Wallace described the muscular responses of the fetus to certain sound stimuli. Since the publication of that report, considerable progress has been made in the accumulation and interpretation of data on this subject. The results of these further experiments are presented here because we feel that they add something to the existing understanding of the physiology of the unborn child. While the phenomena of the response of the human fetus to sound stimuli has previously been reported by Forbes and Forbes (1), Peiper (2), Ray (3) and others, these reports are observations in the main, more or less occasional observations and are not suitable for statistical analysis. In no instance have these investigators attempted to determine the time of onset of this response, its reliability or its changes with increased fetal age.

METHOD OF OBSERVATION

A mechanical arrangement for recording the movements of the human fetus has previously been described by Sontag and Wallace (4). The device consists of a set of four rubber sacks encased in a cloth container, which fits over the maternal abdomen. A plaster of paris cast, fitting snugly the contour of the abdomen, is placed over the rubber sacks and is held in place by a muslin binder which passes entirely around the trunk of the mother. Each of the rubber sacks is connected by a thick-walled, small bore tube to one of a set of four tambours. Each tambour in turn, activates a pen. By this means tracings of all abdominal movements are recorded on a moving ribbon of paper. Respiratory movements can be differentiated from fetal movements by reason of the fact that they cause a synchronous displacement of all four pens, while a movement of the fetus causes a change in shape of the uterus and, therefore, a decrease in pressure in at least one sack necessarily accompanies the increase in pressure in the sack against which the fetal member is being pushed. The resulting record shows a rise in one or more of the pen lines during a fetal movement, which is always accompanied by a lowering of one or more of the other lines.

In our first studies of fetal movement this recorder was used together with the recording of subjective sensations of movement indicated by the mother. The mother indicated such sensations by means of a small incandescent bulb which could be lighted by pressure on a push-button which she held in her hand throughout the

period of observation. Checking of the early records showed a high degree of reliability of the subjective records as compared with the records taken on the fetal movement recorder. Since we wished to listen to the fetal heart during the records, the fetal movement recorder was not used for collection of the data presented here. The record of the sensation of movement as indicated by the mother was used exclusively.

Sound stimuli were applied by means of an ordinary door bell buzzer whose knocker instead of striking a metal bell, was made to strike a small wooden disc which was in contact with the abdomen. When the sixty cycle current was turned into this device, a loud knocking sound was transmitted through the wood block directly to the skin of the mother's abdomen. The sound block was routinely placed over the fetal head, as responses were much more constant when this precaution was taken than when the sound was applied elsewhere on the abdomen. Other sound frequencies were tried, but, either because of differences in the means of applying them or because of the difference in their vibratory frequency, they did not produce a reliable fetal response.

TABLE 1

Comparison of the number of fetal movements per minute before and after auditory stimulation by weeks and months prenatal. Eight patients—195 records

MONTHS PRENATAL	WEEKS PRENATAL	NORMAL FETAL MOVEMENTS PER MINUTE		NUMBER OF FETAL MOVEMENTS PER MINUTE AFTER STIMULATION		CHANGE IN MOVES PER MINUTE WITH STIMULATION		NUMBER OF RECORDS	
		Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
1	1	0.80	1.42	3.16	2.76	2.36	1.34	31	91
	2	1.52		2.23		0.71		30	
	3	2.16		2.87		0.71		15	
	4	1.73		2.93		1.20		15	
2	5	1.79	1.38	2.33	2.09	0.54	0.71	15	53
	6	1.77		2.31		0.54		13	
	7	0.44		1.22		0.78		9	
	8	1.23		2.19		0.96		16	
3	9	0.93	1.15	2.21	1.49	1.28	0.36	14	51
	10	1.25		1.37		0.12		19	
	11	1.32		1.31		−0.01		13	
	12	0.68		0.40		−0.28		5	

EXPERIMENTAL DATA

A total of 214 experiments were made on the seven patients used. Observations ranged from 127 to 1 day before birth. All of the 214 cases are used in table 3. Only 195 of them are used in tables 1 and 2 because the remainder of the 214 were made earlier than three months before the birth of the infant. The infants upon whom experiments were made, delivered from 255 to 288 days after the date of the last menstrual

period. They ranged from 2387 grams to 3454 grams in weight.

Each observation period lasted exactly fifteen minutes with the exception of 12 on one patient which were carried over a half hour period. The fifteen minute periods were divided into a five minute control period and a ten minute period following the sound application. The time of each experiment was divided into minutes and the number of movements in each minute were recorded. In a second treatment of the data each minute was classified as active, if one or more movements occurred in it, and inactive if no movements occurred in it. An attempt to compare the extent or degree of one movement to that of another was unsuccessful.

TABLE 2

Comparison of per cent of time active of the human fetus before and after auditory stimulation by weeks and months prenatal. Eight patients—195 records

MONTHS PRENATAL	WEEKS PRENATAL	NORMAL PER CENT OF TIME ACTIVE		PER CENT OF TIME ACTIVE AFTER STIMULATION		CHANGE IN PER CENT OF TIME ACTIVE AFTER STIMULATION		NUMBER OF RECORDS	
		Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
1	1	44	49	94	86	50	37	31	91
	2	47		93		46		30	
	3	55		87		32		15	
	4	60		77		17		15	
2	5	48	51	93	81	45	30	15	53
	6	69		85		16		13	
	7	31		56		25		9	
	8	51		81		30		16	
3	9	44	51	64	57	20	6	14	51
	10	52		63		11		19	
	11	60		54		−6		13	
	12	44		20		−24		5	

TABLE 3

Showing the number of fetal movements per minute and the per cent of time active for each of the seven patients

NUMBER OF CASES	A 11	B 23	C 23	D 12	E 56	F 59	G 31
M.P.M. normal	0.72	0.83	1.20	1.67	2.13	1.17	0.70
M.P.M. after stimulation	1.90	0.61	3.09	2.58	1.84	1.85	3.42
Change	1.18	−0.22	1.89	0.91	−0.29	0.68	2.72
Normal per cent of time active	30	39	45	53	69	54	42
Per cent of time active after stimulation	70	47	83	92	68	69	100
Change, per cent	40	8	38	39	−1	15	58

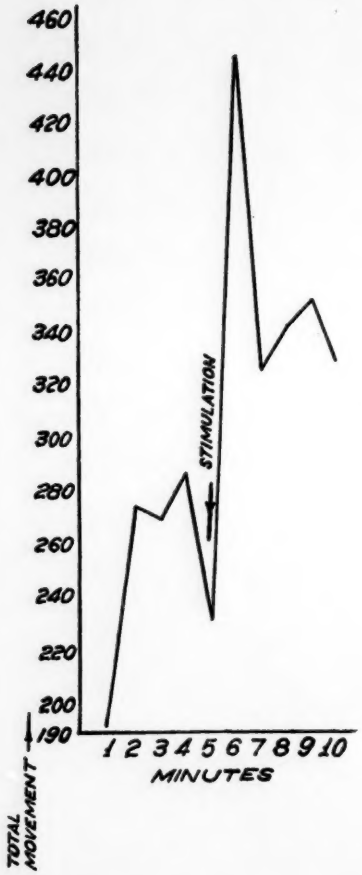


FIG. 1 FETAL MOVEMENT

Five minutes before and five minutes after sound stimulation, showing number of moves per minute before and after stimulation. From 1 to 127 days prenatal. Average 40 days prenatal.

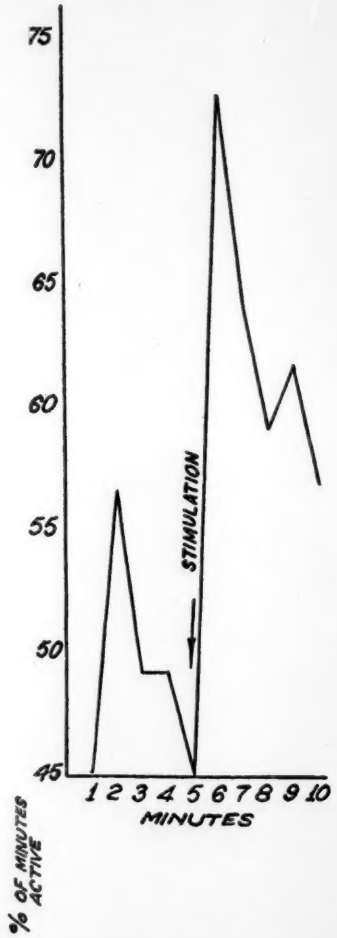


FIG. 2. PERCENTAGE OF ACTIVE MINUTES FOR FETI

Five minutes before and five minutes after. Sound stimulation difference equals 24 ±2.3 per cent. From 1 to 127 days prenatal. Average 40 days prenatal.

RESULTS

In order to determine whether there was an increase in activity in response to the sound stimuli, two comparisons were made. The percentage of minutes during the control period in

which one or more movements occurred, active minutes, was compared with the percentage of active minutes immediately following stimulation. By immediately, we mean the first minute only, following stimulation.

Table 1 shows the average number of movements per minute during control periods, the average number of movements during the first minutes following stimulation and the changes in moves per minute. All these figures are shown in relationship to the number of weeks or months prenatal at which the records were taken. Figure 1 shows graphically the mean increase in the number of moves per minute after stimulation for the entire group. Table 2 duplicates the information of table 1 except that it deals with the percentage of active minutes instead of the number of movements per minute. Figure 2 shows graphically the mean increase in the percentage of active minutes before and after stimulation for the entire group. Table 1 and table 2 show that during the last month prenatal there is almost one hundred per cent increase in both the number of movements per minute and the percentage of active minutes following stimulation. In the eighth month prenatal the response is less marked, but nevertheless, definite. The seventh month shows, in the number of movements per minute, an increase of 24 per cent after stimulation and, in the number of active minutes, an increase of 12 per cent. An examination of the seventh month by weeks reveals the fact that whereas, during the ninth and tenth prenatal weeks, there is evidence of a response to auditory stimulation, the figures for the eleventh and twelfth prenatal weeks show no response to stimulation. When a sufficient number of cases have been studied to determine more accurately the norm for the age of development of these responses, the comparison of the age and degree of response of a fetus to sound stimulation may serve as some index of the degree of development of its neuro-muscular systems. The cases we have studied indicate that there is considerable individual variation in the response of the fetus both as to its development and its reliability on successive days. Although relatively little data are available for tests before the seventh, that which we have shows occasional responses scattered throughout the sixth month.

Table 3 gives the number of movements per minute before stimulation as compared with the first minute following stimulation of each subject. Patient B, during 23 experiments, and patient E, during 56 experiments both show a slight decrease in movements in the minute following stimulation. Whether these negative cases are the result of differences in thickness of the structure overlying the fetal head or whether they are developmental differences which may be demonstrable at birth has not been determined.

SUMMARY

1. In a series of 214 experiments on seven women there was a reliable increase in the detectable fetal movements in the first minute following the application to the mother's abdomen of a sound stimulus of a frequency of 120 per second.

2. The response to sound stimulus is detectable about the beginning of the thirty-first week of intrauterine life.

3. The response increases in magnitude as the fetus nears term. The per cent of time during which the fetus is active by months is:

During the last prenatal month, 49 per cent before and 86 per cent after.

During the second month before birth, 51 per cent before and 81 per cent after.

During the third month before birth, 51 per cent before and 37 per cent after.

CONCLUSIONS

The human fetus is capable of responding to a sound stimulus applied to the maternal abdomen, by increase in movement of the fetal muscles. The response becomes more marked as term approaches. We believe that the development of such a response may furnish some index of the development and maturity of the fetus.

REFERENCES

(1) FORBES, H. S., AND FORBES, H. B.: Fetal sense reactions: hearing. Jour. Comp. Psychol. **7**, 353, 1927.

(2) PEIPER, A.: Sinnesempfindungen des Kindes vor seiner Gubert. Monatschr. F. Kinderh. **29**, 236, 1925.

(3) RAY, WILBERT S.: A preliminary report of a study of fetal conditioning. Child Development **3**, 175, 1932.

(4) SONTAG, L. W., AND WALLACE, R. F.: An apparatus for recording fetal movement. Amer. Jour. Psychol. **45**, 517, 1933.

Variations with Age in Frequency Distributions of Degrees of Handedness

MARY M. ROOS

INTRODUCTION

THERE seems to be no phase of the history of man which does not bear record of his dexterity. Indeed, it would seem that language, social and religious usages, and man's handicrafts throughout the whole period of his existence have been profoundly affected by his preference for the right hand.

The problem of determining probable causes of this preference for the right hand has long engaged the attention of thoughtful men. In fact, there is today a vast literature on the subject. One reading this literature must, however, be deeply impressed by the fact that few studies of statistical significance have been made. As an example of statistically significant studies, it may be noted that Woo and Pearson (6) have made careful statistical studies of the relation of handedness and eyedness using data of 7,000 observations made by Frances Galton.

Several investigators of handedness and its causes have noted that subjects have shown varying degrees of skill with the right or left hand and yet no one seems to have investigated the frequency distribution of this variation in skill. There has also been a great deal of argument regarding the merits of the various tests for handedness,—the writing test, the number marking test, the tapping test, the strength of grip test, etc.,—and yet no one knows just what each really tests and what frequency distribution should be expected from each one. Furthermore, it does not seem to have been recognized that the tests may really be tests for different things,—for instance, that the writing and number marking tests may be tests of how much skill the subjects have obtained in either hand as a result of environment and that the tapping test, for example, may not measure environmental effects to such a great extent.

It would seem that no great quantitative progress in the study of handedness can be expected until the unit of measurement has been standardized. In other words it is of primary importance to determine just what each test measures and how degrees of handedness are distributed in the normal population.

This paper presents a statistical analysis of data gathered to determine the extent of handedness and the frequencies of degrees of handedness in three typical cross-sections which are represented by kindergarten or pre-school children, sixth grade chil-

dren and adult college students in Washington, D. C., U. S. A. Thus, the groups contained children whose ages were approximately four to six years for the kindergarten group, and eleven to thirteen years for the sixth grade group. In the college group some subjects were 16 years of age and some above 20 years, but the vast majority were between the ages of seventeen and twenty. I wish to acknowledge my indebtedness to Miss Jessie La Salle of the Washington, D. C., public school system, who made possible the study of the kindergarten and sixth grade children, and also to Professor Fred A. Moss for his many valuable suggestions, and for his coöperation in the gathering of data, and to Professor Charles F. Roos for his helpful statistical advice.

TESTS OF HANDEDNESS

The 3 groups, kindergarten, sixth grade, and college students were given a tapping test for handedness. Each subject was brought before a telegraphic key and asked to tap it at his maximum rate for exactly sixty seconds as recorded by a stop-watch. Care was taken to make sure that the subject understood what was expected of him before the tapping began. Each subject was given a brief practice period with each hand and then allowed to tap. The number of taps was automatically recorded by an electric counter.

To make certain that the kindergarten children should not know that their handedness was being tested and perhaps definitely try to prove themselves right-handed in order to avoid a possible odium, they were told that the test was to see how fast they could tap with each hand. This explanation sufficed, and it is believed that there is no bias in these data. In the case of the sixth grade this precaution to avoid bias was not exercised. The sixth grade data were the first to be taken and were recorded before it was realized that subjects might attempt to prove themselves right-handed if they knew that their handedness was being tested. This tendency was particularly noticed in a later college group for which the observations were thrown out. One might expect more bias in the case of college students than in the case of sixth grade children. The latter would quite naturally be awed by the presence of a tester who carried credentials from the office of the Superintendent of Education and would, therefore, not be apt to do other than told. Analysis of the data indicates, furthermore, that if there is any bias in the sixth grade data, it is very slight. In obtaining the data for the college students that are recorded here, the subjects were told that the test was one of reaction time. Each subject was inspired to tap with a maximum effort in each hand in order to prove himself to have a high reaction time. Approximately three hundred subjects were tested in each group.

For a grip test, readings were taken with a squeeze dynamometer for both hands of 242 college students. Three readings were taken from each hand, with the hands being used alternately to obviate differences due to practice or fatigue. The average of the 3 readings for the right hand and the average of the 3 readings for the left hand are recorded in table 1B.

The technique of the number marking test involved the drawing of short vertical lines through numbers on a sheet of numbers as rapidly as possible. An initial practice period of 60 seconds was given each hand. This was followed by 2 thirty second marking periods given alternately to the right and left hands. The results of this investigation are given in table 1A.

In the case of the tapping test, a record of the reported handedness of individuals in the college group was made to compare with the tested handedness. The reported handedness was recorded after the tests for reaction time had been completed. Table 2 gives the results of this comparison of reported handedness with tested handedness. There is no need to explain this table other than to say that of the 265 subjects tested all except 3 who said that they were left-handed indicated left-handedness by

TABLE 1

Frequency distributions—College students

A. NUMBER MARKING TEST					B. STRENGTH OF GRIP TEST				
Class logarithms	Class intervals x	t_n	F_n	f_n	Class logarithms	Class intervals x	t_g	F_g	f_g
−.235	−9	−3.766	2	0	−.135	−6	−3.675	1	0
−.185	−8	−3.350	2	0	−.110	−5	−3.139	1	0
−.135	−7	−2.934	2	1	−.085	−4	−2.602	2	2
−.085	−6	−2.518	3	2	−.060	−3	−2.066	3	6
−.035	−5	−2.102	4	6	−.035	−2	−1.530	13	16
+.015	−4	−1.685	6	14	−.010	−1	−.993	36	31
+.065	−3	−1.269	15	25	+.015	0	0	44	51
.115	−2	−.853	31	40	+.040	1	.080	58	51
.165	−1	−.437	66	52	.065	2	.616	36	42
.215	0	0.000	75	57	.090	3	1.153	34	26
.265	1	.395	54	52	.115	4	1.689	8	12
.315	2	.811	46	41	.140	5	2.226	4	4
.365	3	1.228	17	27	.165	6	2.762	2	1
.415	4	1.612	10	16					
.465	5	2.060	4	7					
.490	6	2.476	2	3					
.540	7	2.892	2	1					
.590	8	3.308	1	0					
.640	9	3.725	1	0					
Totals.....			343	343				242	242

Number marking test:
Mean = .050 Class intervals = .240 + .0025 = .242
Standard deviation = 2.4033 Class intervals = .050 × 2.4033 = 1.2017
$\frac{N}{\sigma} = \frac{343}{2.4033} = 142.720$

Strength of grip test:
Mean = .851 Class intervals = .0275 + .0213 = .0488
Standard deviation = 1.864 Class intervals = .025 × 1.864 = .0464
$\frac{N}{\sigma} = \frac{242}{1.864} = 129.828$

the tapping test. These 3 were shown by the test to be ambidextrous. On the other hand a number of those who reported themselves to be right-handed tested left-handed by the tapping test. The reason for this apparent failure of the tapping test is that the tapping test presumably measures what may be called native handedness as opposed to acquired handedness.

TABLE 2

Reported handedness compared with tested handedness

College students

TAPPING TEST CLASS BY RATIO	REPORTED HANDEDNESS			
	R	A	L	T
.69	2	0	2	4
.73	3	0	1	4
.77	1	0	0	1
.81	2	0	2	4
.85	3	0	1	4
.89	8	0	4	12
.93	6	0	5	11
.97	11	1	1	13
1.01	29	1	3	33
1.05	41	1	0	42
1.09	20	1	0	21
1.13	31	0	0	31
1.17	26	0	0	26
1.21	8	0	0	8
1.25	25	0	0	25
1.29	9	0	0	9
1.33	5	0	0	5
1.37	1	0	0	1
1.41	7	0	0	7
1.45	4	0	0	4
Totals	242	4	19	265

R = righthanded; L = lefthanded; A = ambidextrous; and T = R + A + L.

INDICES OF HANDEDNESS

It is not enough to say that human beings are right or left-handed. For instance, suppose that subject *A* registers 125 taps with the left hand and 200 taps with the right hand. It may be concluded that subject *A* is right-handed, but this does not adequately describe his right-handedness, for subject *B*, who taps 190 with his left hand and 200 with his right hand, is also right-handed. It can hardly be said that subjects *A* and *B* possess the same degree of right-handedness.

The quantity, R/L, where R represents the number of taps made by the right hand, or the right count, and L is the number of taps made by the left hand in the same period of time, or the left count, may be taken as a measure of the degree of handedness. Hereafter, this ratio, R/L, will be called a *handedness ratio*. It gives a quantitative measure of degree of handedness. It describes always the relationship between the two hands, not the reaction time of either hand, nor the number of marks made by either hand. Thus, it is simply a number, that is, it does not have dimension. It serves very well to eliminate the personal elements that naturally vary with individuals.

If subject *C* taps 250 with the left hand and 400 with the right hand, then, according to the handedness ratio, subject *C* has the same degree of right-handedness as subject *A* who taps 125 and 200, respectively, with the left and right hand, for, $R/L = 400/250 = 200/125 = 1.60$. If subject *D* taps 300 and 200, respectively, with his left and right hands, then his degree of left-handedness is $R/L = 200/300 = .67$. Theoretically, one represents ambidexterity, but due to the nature of the tests used and the

statistical elements involved, it is probably better to say that ambidexterity is defined by an interval having one as its mid-point, for example, by the interval .95 to 1.05. For the purposes of this study it is, however, not necessary to define what is meant by ambidexterity.

The ratio, R/L, has one obvious disadvantage as a measure of degree of handedness. By definition the range of right-handedness is from one to infinity (paralysis of the left-hand), whereas the range of left-handedness is from zero (paralysis of the right hand) to one. In other words the ratio is an asymmetrical index of degree of handedness. As a symmetrical index of handedness the logarithm of R/L naturally suggests itself. For this index left-handedness is distributed over the range minus infinity to zero, and right-handedness over the range zero to plus infinity. There is, therefore, no bias either to the right or to the left, and, furthermore, the logarithm is a function that takes into account relative differences which seems to be what is desired. It may, therefore, be regarded as an ideal index of handedness and is used in this paper.

FREQUENCY DISTRIBUTIONS OF HANDEDNESS RATIOS

Table 3 gives the observed distributions of handedness ratios determined by the tapping test for the kindergarten, sixth grade and college groups.

The percentages which tested left-handed in the kindergarten, sixth grade and college groups are respectively 18.6, 19.2 and 17.2. The differences, which can not be regarded as significant, indicate that there may be little disagreement in the incidence of right and left-handedness in the three widely separated age groups studied, provided the tapping test is used. It will be shown presently that this is probably the case. The percentages given by the present study do not agree with the 4.62 per cent of boys and the 2.62 per cent of girls who were left-handed that has been reported by Wilson and Dolan (5) in their study of 2328 junior high school students. They do agree, however, with the twenty per cent of left-handedness and ambidexterity reported in a study (1) of the natives of Murray Island, and the 18.3 per cent of left-handedness obtained by the author (4) in a study of 486 infants. On the other hand, Wilson and Dolan used a writing test and their percentages are in approximate agreement with the percentages obtained in that part of the present study in which a number marking test was given to college students. Furthermore, the strength of grip test was given to the Murray Islanders and as will appear from the present study, the mean and standard deviations for the grip test and tapping test as applied to the same group of college students are very nearly alike. Further analysis seems to indicate that the tapping test and strength of grip test probably measure native handedness as distinct from acquired or learned handedness.

The 296 kindergarten children range in degrees of handedness from $-.1600$ to $+.2150$ (logarithmic indices) with the arithmetic mean at $.0484 \pm .0022$, where .0022 is the probable error. For this group, the standard deviation is $.0560 \pm .0016$. Both the mean and

the standard deviation are very large compared with their probable errors, and hence are highly significant. The 398 college students range in degrees of handedness from −.1850 to +.2400 the mean being .0415 ±

TABLE 3

Frequency distributions—tapping test

CLASS INTERVAL	MIDPOINT X	KINDERGARTEN			SIXTH GRADE			COLLEGE				COMBINED		
		t_k	F_k	f_k	t_s	F_s	f_s	t_c	F_c	f_c	ϕ_c	t_g	F_g	f_g
−.185	−.1725	−3.9446	0	0	−3.7103	0	0	−3.7676	2	1	2	−3.7907	2	0
−.160	−.1475	−3.4982	1	0	−3.2964	2	1	−3.3275	1	1	2	−3.3581	4	1
−.135	−.1225	−3.0518	1	1	−2.8825	1	1	−2.8873	2	2	4	−2.9256	4	2
−.110	−.0975	−2.6054	2	2	−2.4686	3	2	−2.4472	6	3	4	−2.4931	11	8
−.085	−.0725	−2.1589	4	5	−2.0546	6	6	−2.0070	3	9	5	−2.0606	13	20
−.060	−.0475	−1.7125	11	12	−1.6407	12	12	−1.5669	19	20	11	−1.6280	42	45
−.035	−.0225	−1.2661	15	24	−1.2268	15	22	−1.1268	21	37	27	−1.1955	51	83
−.010	.0025	−.8196	48	38	−.8129	35	34	−.6866	52	53	54	−.7630	135	128
.015	.0275	−.3732	54	49	−.3990	39	44	−.2465	84	68	84	−.3304	177	161
.040	.0525	.0732	50	52	.0149	61	48	.1937	87	69	85	.1021	198	169
.065	.0775	.5196	38	46	.4288	35	44	.6338	59	57	60	.5346	132	148
.090	.1025	.9661	36	33	.8427	43	34	1.0739	34	39	32	.9671	113	106
.115	.1275	1.4125	23	19	1.2566	23	22	1.5141	11	22	12	1.3997	54	64
.140	.1525	1.8589	8	9	1.6705	10	12	1.9542	8	10	6	1.8322	29	32
.165	.1775	2.3054	4	4	2.0844	3	6	2.3944	6	4	5	2.2647	13	13
.190	.2025	2.7518	1	1	2.4983	3	2	2.8345	1	1	3	2.6972	5	4
.215	.2275	3.1982	0	0	2.9123	0	1	3.2746	2	1	2	3.1298	2	1
			296	296		291	291		398	398	398		985	985

Statistics of frequency distributions

STUDY	OBSERVATIONS	MEAN	PROBABLE ERROR OF MEAN	σ	PROBABLE ERROR OF σ	N/σ
Kindergarten	296	.0484	.0022	.0560	.0016	132
Sixth grade	291	.0516	.0024	.0604	.0017	120
College	398	.0415	.0019	.0568	.0014	175
Composite	985	.0466	.0012	.0578	.0008	426

Here, F_k, F_s, F_c, and F_g are observed frequencies; subscripts k, s, c, and g, stand for kindergarten, sixth-grade, college, and combined, respectively; t_i is equal to (X − Mean of i^{th} Distribution)/σ_i where i = k, s, c, and g; $f_i = N_i\phi(t_i)/\sigma_i$; $\phi_c = f_c + 353\phi^{(4)}(t_c)/4!$; N_i is the total number of observations in the i^{th} set; σ_i is the standard deviation of this set in class intervals: and $\phi_i(t_i)$ is the normal probability function and $\phi^{(4)}$ (t_c) is the fourth derivative of $\phi(t_c)$.

291 sixth graders range in degrees of handedness from −.1600 to +.2150 the mean being .0516 ± .0024 and the standard deviation .0604 ± .0017. .0019 and the standard deviation .0568 ± .0014.

It is readily seen that the range of handedness is just about the same

for all 3 groups. Also, the means, .0484 ± .0022, .0516 ± .0024, and .0415 ± .0019, are very nearly alike. Similarly, the standard deviations of .0560 ± .0016 for the kindergarten group, .0694 ± .0017 for the sixth grade group and .5680 ± .0014 for the college group are not greatly different.

It is interesting, therefore, to compare these statistics, *e.g.*, the mean and standard deviation of each group, with the mean and standard deviation of a composite group of 985 subjects consisting of the 296 in the kindergarten group, the 291 in the sixth grade group, and the 398 in the college group to determine the probability that the mean or standard deviation of any random sample taken from the composite group, here assumed to give the best estimates of the mean and standard deviation for the universe, will exhibit the variations in the three samples presented here. The mean for the composite group may be calculated directly as .0466 ± .0012 and the standard deviation as .0578 ± .0080.

To detect significant differences in the samples, the difference between the composite mean and the mean for each sample may be compared with their probable errors. It is well known that the probable error of the difference of two quantities is the square root of the sum of the squares of the probable errors of the quantities. See, for instance, Jones, (3). A short calculation shows that the difference of none of the means is greater than 3 times the probable error of the corresponding difference. Similarly, it is easy to show that the maximum difference of each standard deviation is less than the corresponding probable error so that again differences are not significant.

Thus, consideration of only the first 2 moments, leads to the conclusion that all 3 samples, kindergarten, sixth grade and college probably came from the same universe, that is, that living in a right-handed world probably has no influence on the distribution of degrees of handedness as measured by the tapping test. An important problem, therefore, is to determine whether or not the third and fourth moments are significant and if they are significant, whether or not differences in these moments can be attributed to sampling errors.

An application of the Pearsonian Chi Square Test of Goodness of Fit (2) to the data for the kindergarten group shows that despite the discrepancy pointed out in the −.035, −.010, .065 class intervals, the normal curve gives a very good fit. On the basis of this test one would naturally be led to conclude that the distribution of Log R/L for the kindergarten group is normal. In view of the results of the sixth grade and college groups to be presented shortly, it is, however, more likely that a slight shift to the right occurred in the left-handed groups −.035 and −0.10.

When calculations for the sixth grade are made as they were for the kindergarten group, it is found that the normal distribution given by column f_s in table 3 seems to agree very well with the observed frequency F except for the class intervals −.035 and .065 where disagreement was found for the kindergarten group.

On the other hand, for the college

group, the normal distribution given by column f_c does not seem to afford a good fit to the observed frequencies. Indeed, a short calculation indicates that there is about one chance out of twenty that a sample drawn from a normal universe would differ from the normal as much as does this sample. A comparison of the difference between the observed frequencies and the calculated normal frequencies shows that the fit will be materially improved by adding a kurtosis function to the normal curve. In fact, the frequency distribution

$$f_c = (N/\sigma)\varphi(t) + (K_4/4!)\varphi^{(4)}(t)$$

where $K_4 = 352.8$ and N and σ have the values given in table 3, adequately represents the distribution for handedness of college students, the chances being a little better than even that the sample came from the distribution given by the normal probability function $\varphi(t)$ and its fourth derivative.

It is not unreasonable to suppose that the distribution of the handedness index would change from the kindergarten age to the college age, as indicated here, that is, that in the college group there should be a greater concentration than normal around the mean at the expense of adjacent regions.

The fact that the mean for all groups is definitely on the right-handed side would be sufficient to explain the world-wide preference for the right hand. If the mean be taken to indicate the usual preference given to the right hand in a right-handed world, then it might be expected that continued application of this conventional preference by individuals whose handedness indices were several units on each side of the mean would tend to change their indices into ones nearer to the mean. Thus, there would be a concentration about the mean, as indicated by the college group.

In the case of the kindergarten and sixth grade groups it may be said that this tendency to group about the mean has not had time to manifest itself. It will be recalled, however, that in both the kindergarten and sixth grade groups shiftings in the groups near the means toward the means were slightly indicated.

In view of the results presented here, it is indicated that the handedness index of a group of infants, as measured by the tapping test or some other test of what may be called native handedness, would be distributed normally, that is, that Log R/L would be distributed normally.

This study suggests the important hypothesis that there is no one assignable cause of degrees of right or left-handedness, but rather that there are a great many equally important causes. In view of the great number of theorizings that have been published on the causes of right and left-handedness, this conclusion is an important one (4).

FREQUENCY FUNCTIONS FOR THE STRENGTH OF GRIP TEST

The results of a strength of grip test administered to 242 college students are explained in section two and summarized in table 1B. The mean and standard deviation do not differ greatly from the mean and standard deviations of frequency distributions for the tapping test, and, furthermore, Log R/L is distributed normally.

The frequency distribution for the grip test, however, does not show the concentration about the mean shown in the case of college students given the tapping test. This may mean that the former is a better test of native handedness than the latter when applied to adults. It might be expected that such predominantly right-handed activities as writing would be more apt to modify the frequency distribution of the tapping ratio or tapping index than they would the strength of grip. In other words, it may be possible that throughout life the left hand is used for gripping purposes in approximate accordance with the infant distribution of the handedness index, but a great deal more experimentation is necessary to prove or disprove this hypothesis.

FREQUENCY DISTRIBUTION FOR THE NUMBER MARKING TEST

Table 1A summarizes the observations in connection with a number marking test administered to 345 college students as explained in section 2. Here the handedness index Log R/L is almost certainly not distributed normally. Nor is the distribution for the number marking test simply modified by skewness and kurtosis. In a general sort of way the distribution reminds one of the normal curve, but it cannot be considered to be normal. In particular, there seems to be marked deficiency in the classes on each side of the mean, and marked excesses in both right and left extremes. It may be verified readily that in order to obtain a satisfactory fit, it is necessary to include terms to $\varphi^{(7)}(t)$. There is, however, no reason for expecting the distribution for the number marking test to be normal since learning has definitely played a part in modifying an indicated normal curve at birth.

CONCLUSIONS

On the basis of the results presented here, it would seem reasonable to conclude that:

1. It is indicated that the logarithmic handedness index of a group of infants as measured by the tapping test or some other test of what may be called native handedness, is distributed normally, that is, that Log R/L is distributed normally.

2. Handedness is a trait which is manifested in varying degrees in different individuals and the age of the subjects does not materially affect the degree of its manifestation when it is measured by a tapping test or a strength of grip test.

3. About 81 per cent of people show greater native ability with their right hand than with their left as indicated by the tapping test, whereas approximately 96 per cent learn to use their right hand preferentially as indicated by the number marking test. In other words, 75 per cent of those who have greater native ability in their left hand as indicated by reaction time (tapping test) develop preferential use of the right hand presumably due to the effect of living in a right-handed world.

4. The theory that handedness is an inherited quality finds support in this investigation, for, among the samples, the kindergarten, the sixth grade, and the college groups, the statistics of the mean, the mode, and the standard

deviation, do not vary more than is expected by chance. This thesis finds further support in the author's study on an infant group.

REFERENCES

(1) Cunningham, D. J.: Right handedness and left-brainedness. Huxley Memorial Lecture, 1902. Jour. Anthro. Institute, **23**, pp. 273–296.

(2) Fisher, R. A.: Statistical methods for research workers, London, Statistical, 1930, p. 96.

(3) Jones, D. C.: A first course in statistics, London, 1921.

(4) Roos, Mary M.: Some factors entering into the determination of handedness. Child Development, 1935, **6**, No. 2.

(5) Wilson, M. O., and Dolan, L. O.: Handedness and ability. Amer. Jour. of Psychol., **63**, 1931, pp. 261–268.

(6) Woo, T. L., and Pearson, Karl: Dextrality and sinistrality of hand and eye. Biometrika, **19**, pp. 165–166.

An Experiment with Posture Work in a Nursery School. A Preliminary Report

DOROTHY W. BARUCH, M.E. AND JOSEPH C. RISSER, M.D.
ASSISTED BY CAROLINE BARZEN AND MARY CHAMBERLAIN

INTRODUCTORY STATEMENT

GOOD posture is undoubtedly an enviable asset. Development of muscle groups upon which good posture depends cannot begin too early. Anything which motivates children in the right direction here will undoubtedly be of advantage to the continuation of their healthful living.

Desirable as is a posture program in the nursery school where children of from two years to nearly five come together, it has not often been a feasible endeavour to carry out. In the first place it is not often feasible to have elaborate posture apparatus in a nursery school. In the second place, it is not often feasible to have in daily attendance a trained expert in posture who can give to the children both passive and active corrective and developmental exercises. Hence to evolve a posture program which could be simply carried on by nursery school teachers appeared highly desirable. In consequence a first question arose:

What can the teacher who has had little or no posture training do under the occasional direction of a consulting orthopedist and without elaborate posture equipment? Can she in the natural environment of the nursery school help the children to correct development of those muscle groups upon which good posture depends?

The first solution that occurs is to arrange exercise periods and have the nursery school teacher learn how to give certain simple exercises to the children. But on further consideration such a solution seems both premature and lacking in thoughtfulness. The nursery school child is in a developmental period of growth where attention to tasks imposed by others is difficult. He is exceedingly active, but his activities have short duration span and shift quickly.

Activities imposed on him in a set form by others not only fail to appeal after their first novelty has worn off, but often call forth outright negativism. The child during these early years is called on to learn so many fundamental habits at the will of others, that if many additional items are asked of him, he begins to balk at everything. Psychologists have pointed out that demands are best limited to routines of eating, sleeping, elimination, and to safeguarding from danger for children between two and five. They tell us that the negativism which children evidence at this period is a necessary phase in the develop-

ment of independence, and just for this reason advise rigid curtailment of as many imposed tasks as is possible lest the negativism have so much to feed on that instead of independence, rebellion results. Hence posture exercises which are set in form by the adult, even though sugar-coated into "games" run the danger of either calling forth negativism in direct response to them, or of intensifying the general negativism in the child at other times during his day, because of their contribution to an already heavy load of things being imposed from without onto an organism seeking for the first time to feel itself independent.

When we stop to think we realize how vital it is for a normal amount of independence to grow. We realize that in whatever guidance we do, we must help such growth rather than run the danger of shaping the child into a dependent, submissive person who turns out lacking in stamina and forcefulness. A second danger in too many imposed tasks confronts us here. As had been said too many imposed tasks may intensify the child's negativism. With some children this is true. With others just the opposite may occur. Instead of becoming negative the child may become submissive to adults, seek to comply to gain favor, and finally come to need others to initiate, inaugurate and to sanction activities. Thus with a certain rather sensitive type of child, too many imposed tasks in the preschool period can do this instead of its opposite. So again, we are faced with the problem of the necessity for guarding against set, imposed exercises in our posture program.

On the other hand, activities that are spontaneous, that have meaning to the child, that are done for their own sake because of the fun of doing them —activities which are not too much patterned by the adults around, but instead are activities which the child himself thinks of doing—such activities are repeated again and again. They become a part of the child's vital and vigorous play, they become functional in his living. Such, then, are the sort of activities which we must try to find ways of incorporating into a posture program for the nursery school.

PURPOSE

An experiment was undertaken to work out in a nursery school a posture program which would be a feasible one for the regular nursery school teacher to carry on under the occasional direction of a consulting orthopedist; and which would, moreover, be adapted to the age, interests and capacities of children between two and five.

It was agreed that to do this the program would need to steer away from the didactic and from set exercises. It would need to fit in with the natural environment and play activities of the children. It would need to lend itself to free and spontaneous use by the children. In short it would need to be a functional program in which healthful postural habits might grow in the natural work and play of the day.

Procedure

The study was carried on from March 3, 1935 to June 3, 1935, in the Broadoaks Nursery School of Whittier College.

1. Special needs of the children in the nursery school where the study was undertaken were determined through measurement, examination and photographs by the orthopedist.

2. The general postural needs of children from two to five were outlined by the orthopedist. It was agreed to work out the program under consideration, with special emphasis placed on development of feet and lower spine. The posture objectives included the following:

A. Feet
   1. To lessen inherited contractures and to have feet accomplish at least a 90 degree dorsal flexion.
   2. To develop plantar-flexor muscles.
   3. To make it habitual to walk with foot somewhat inverted, i.e. with feet pointing straight ahead.

B. Pelvis
   1. To incline pelvis backward—to create a roll of pelvis backward in order to prevent or eliminate lumbar lordosis.
   2. To develop the buttocks or gluteal muscle group.
   3. To stretch the hamstring muscle group.

C. Trunk
   1. To develop abdominal muscles.
   2. To educate thoracic-spinal muscles by contraction and shortening.

3. The nursery school environment at the Broadoaks School of Education, Whittier College, was gone over by the orthopedist with the view in mind to note (*a*) those pieces of equipment and (*b*) those activities already going on as part of the nursery school program, which if utilized, or accented, or encouraged, might help the children's posture.

4. The addition of further simple and inexpensive pieces of equipment, or slight changes in equipment already in the environment was considered, and carried out.

5. The addition of greater opportunities for the sort of play and for the use of the equipment which would develop good postural habits was gone into and utilized.

6. Means of accenting the use of equipment and of encouraging spontaneous activities in order to carry out the posture objectives were tried out with the children.

Subjects

Thirty-six children enrolled during the spring semester of 1935 in the two nursery school groups at the Broadoaks School, Whittier College, were the subjects of this study. No special posture work had been given to these children previously. The distribution of subjects according to age levels is given in table 1. The entire group used in this study ranged in age from twenty-one months to fifty-seven months at the time the study was begun.

TABLE 1

Distribution of cases by age and sex

AGE RANGE TO NEAREST MONTH	NUMBER OF		
	Boys	Girls	All
21–35	5	5	10
36–47	5	12	17
48–57	6	3	9
Total...	16	20	36

Program evolved:

1. Measurements and examination of each child were made by the orthopedist.

2. Equipment was arranged and opportunities made for posture activities to go on quite naturally during the children's daily play, as follows:

A. Activities for developing the feet.
   1. To help lessen inherited contractures and to have feet accomplish a greater degree of dorsal flexion, inclined boards were arranged having one end resting on the ground, and the other end on boxes. These were already popular in the nursery school yard. By seeing that the boxes were from 25 to 36 inches high, the angle could become acute enough to automatically make for foot flexion stretching heel cords, as well as hamstrings, as the children went up.
      A song about climbing up the board sung by an observant teacher when she noticed children nearby served to draw their attention to the boards and so encouraged the use of them daily. The children, however, were never lined up and formally put through this or any of the following activities. The stage was set so that the activities could take place, and the children were encouraged individually to enter into them, but never were they formed into groups that went through drills or didactic exercises.
   2. In order to help make it habitual to walk with the feet somewhat inverted, (i.e. pointing straight ahead) the lines on the tennis court which was used as a part of the regular play-yard, served as admirable equipment, (as could any straight line drawn with chalk, or other material).
      Walking on these lines proved to be greatly enjoyed and automatically brought the desirable inverted position of the foot.
      A teacher singing a song about walking on the line, quite incidentally now and again throughout the day, invariably attracted three or four children at a time, each one wanting "a turn" to have the song sung to him while walking.
   3. Plantar-flexion appeared to take place somewhat, even though shoes were on, as the children climbed on the round rungs of the jungle gym.

B. Activities for the pelvis.
   1. As children play, they often "squat" or kneel. It was observed that the squatting, which they do with heels as well as the front part of the feet on the ground, throws the pelvis into good position. Hence when children played building blocks, digging in the ground or sand, and so on, they were encouraged individually to "sit on their feet" instead of their knees.
   2. To develop the large buttock muscles (or gluteals).
      a. A little low fence onto which the child could lean forward and support himself was added to the nursery school equipment. Behind it a ball was suspended from the horizontal bar, so that the child, leaning forward supporting himself on the fence, could kick out backward, bringing the gluteal group into play.
         The teacher would sing about kicking "your foot way back at the ball," helping to attract attention to this type of activity.
   3. To stretch hamstrings or develop quadriceps.
      a. Talking or singing about dogs invariably would bring dramatic play in wake. Children would go down on hands and knees, barking and crawling about.
         It was a simple thing to ask then, if dogs walked on their knees or their feet. A picture was shown. "Oh," said a child, "They walk on their feet," and down he went, not on knees this time, but on hands and feet. Further encouragement from time to time to keep knees straighter was given, and although perfectly straight knees were not achieved

frequently, yet they continued to move in the right direction, for extension.

b. Often children pick up things from the ground, "Can you pick them up while your legs stay straight?" (because of postural objectives) came to be a challenge, so much so that one day a child at music time around the piano, demanded to play picking up rocks with straight legs. Thus both as picking up happened actually in their play and as they dramatized it, the children were having opportunities for good extension of hamstrings.

c. The muscles at the front of the thigh (the quadriceps) came in automatically for much exercise as the children used tricycles, or jumped on the jumping boards, climbed up and jumped down off the low platforms and boxes or climbed on the jungle gym.

C. To develop muscles of the trunk.

1. To develop abdominals.

One day a lady bug was seen on its back, kicking its legs. The children were greatly interested. One child got down onto the floor and dramatized the bug's kicking. "I'm the bug kicking," he said.

The teacher immediately fitted a song to the activity. A rug was laid on the ground. Several became bugs, kicking in the air. Thereafter, whenever the song about the bug was sung, either outside under the trees or inside at "music time," children would navigate to the singer, and begin this activity.

The teacher encouraged that legs stay high enough to be at right angles to the body so that the lower back automatically remained touching the floor.

b. The barrel in the yard was dramatized also by several children. With just a few suggestions, this turned into rolling from side to side, with knees clasped in rhythm to a song sung to those children who at the moment felt like entering in.

2. Toward the end of the experiment a boat was introduced, on which the oars were fastened to the sides with ordinary door springs, so that there was resistance met both in pulling back and pushing forward, excellent for the shoulder and trunk muscles.

3. As the children made use of a low board swing, it was found that use of all trunk muscles took place, especially the abdominals.

4. Climbing on the jungle gym appeared good for all trunk muscles—as well as for the pelvic groups and for development of feet.

All through, hanging on the bar, proved of interest, and was considered good for general stretching and relaxation.

Again, it must be stressed that in none of the above was there lining up of the children and putting them through the paces. This will be clearly seen as examples are read in the concluding section of this paper, as outcomes are described.

Means of accenting the use of equipment and of encouraging spontaneous activities in order to carry out the posture objectives, were found effective as follows:

1. Songs to attract the children to pieces of apparatus by directing their attention to them.
2. Introducing into music period, songs for dramatization which automatically —or with very limited suggestion brought forth developmental use of muscle groups.
3. Having apparatus interestingly arranged, and differently arranged from time to time to attract attention.
4. Shifting or moving apparatus while children were around to focus interest and hence call forth use.

Not being a set program, part of the carrying out involved a means of checking each day those children who participated at one time or another during the morning in the activities for posture development. A check list was therefore posted for this purpose. Its checking each day assured the teacher's being able to determine which children would be needing more stimulation and encouragement to enter in.

OUTCOMES FOR THE FIRST FOUR MONTHS OF THE EXPERIMENT

1. As will be recalled, the first aim of the experiment was to set up, or emphasize activities which would bring into play correctly certain muscle groups important for posture development in a way that could be carried on by nursery school teachers, with no particular posture training, under the occasional direction of an orthopedist.

Whether or not the work was fitting in with this aim has been carefully watched. The director of the nursery school, two full-time teachers and nine student-teachers have been carrying on the work with occasional direction from the orthopedist. None of these teachers had any training in such work, yet none of them found it difficult to carry it on in a way that seemed correct as checked by the orthopedist.

This then, would seem to indicate that such a program is feasible for the average teacher under occasional expert direction.

2. A second aim was to have the posture program adapted to the age interests and capacities of children between two and five.

In regard to a fitting in with capacities first, the fact that all the 36 children enrolled in the nursery school were able to enter into the activities independently without any adult assistance and without any apparent feeling of strain or insecurity, indicated that there was nothing too difficult or beyond their capacities in the program.

As to whether or not the program fitted in with their interests, the greatest surprise came here. Tremendous interest was shown. A teacher would sing a song, for instance, about "Walking on the line" when she caught sight of a single child in the vicinity of one of the lines on the tennis court which served as a part of the nursery school playground. In response, not only would the child already near the line enter in, but others in addition would come running to join the line walkers. Or if the teacher would sing about one child kicking backward (for buttock group development), or about one walking up the board (heel cord and ham-string stretch), along would come others demanding "a turn too." Or the mere sight of rugs being spread on the ground, would bring half a dozen or more children running "to kick like bugs" (abdominals) while still others would demand turns here also. And so on, with each single one of the activities within this program.

According to the careful check list kept, out of the 36 children, 34 entered in *every single* day voluntarily. Two children only needed direct suggestion or a bit of urging. From this it can be seen that interest all through was high.

Examples of activities, jotted down as the incidents were observed, during

the last two weeks of the semester follow to illustrate the sort of responses the children made to indicate the interest they were taking in activities for posture development.

5-24-35: Marion (3/10)[1] is walking on the tennis court carrying her doll. The teacher, seeing that she is near the line and not engaged in any purposeful activity, starts to sing, "let us walk on the line, etc." Marion smiles, and starts line-walking. Hearing the song, Jock (4/10), Peggy (4/6), Prenty (4/0) and Kingsley (3/11) come running. They start to walk lines. Kingsley beams, "I'm doing it too." This goes on for about five minutes.

5-29-35: Marion notices that the boards of the wooden floor inside the house "make lines." She starts to walk along them, becomes engrossed in so doing. Smiles at another child, "I'm walking on the line in here."

5-29-35: Drucilla (3/6) found that she could walk along a six-inch board in the yard. She called to Roberta (3/0) that she was walking on a new line. Roberta joined her.

Notice that in the three instances cited above, the teacher suggested the activity in the first only (and then merely by singing a song), while in the other two instances the children themselves initiated and carried on.

Note too, that in the second and third instances the children adapted other equipment (not the lines on the court which the teacher had suggested), thus truly incorporating into their living the exercising of these particular muscle groups.

[1] (3/10) indicates the child's age, *e.g.* reads as 3 years, ten months, (4/0) as 4 years, zero months, etc.

5-23-35: Jackie (2/0) was near the apparatus for "kicking back at the ball." The teacher nearby started to sing, "Jackie is kicking way back at the ball, etc." Jackie at this leans over the fence and begins kicking back. Several other children come running for turns when Jackie is through.

5-24-35: Theanne (2/6) and Beverly (3/0) are running about together. Theanne catches sight of the apparatus for kicking back. She runs to it. "Let's do the funny trick," she says. She and Beverly then take turns doing it, each having about three turns at it.

5-30-35: George (4/1) and Linda (4/0) have climbed high up on the jungle gym. George suggests that they do a "funny trick" up there. They bend over one of the rungs, and kick back, repeating in their own inventive way, the movement done over the fence for the buttock group.

5-21-35: Kim (23 months) and Nancy R (2/6) and Nancy Y (2/6) take turns walking "Up the board" as the teacher plays on a little wooden flute, the tune that by now has become familiar as singing about going "up, up, up, up the board." An hour later, Nancy comes by herself, takes a running start, and laughing the while, runs up the board. She repeats this five times in succession.

5-22-35: A group of six are gathered around the piano. The teacher sings a song about "Bow wow Doggie walks around." Down onto the floor go all six children, on hands and feet, dramatizing the dog's walking, and incidently stretching hamstrings.

5-23-35: A rug has been spread outside on the ground under an olive tree's shade. The teacher sings about "Kick your heels in the air, like a great big bug," Marjorie (3/0) nearby hears the song. She comes over with, "I be a bug, only a

little bug—a little red lady bug; I kick like he do when he on his back." Soon Barbara (3/3), Drucilla (3/6) and Janet 3/0) join. Later Marjorie returns, after the teacher is no longer there. She laughs, "I kick again." Roberta hears, and silently comes and lies down beside her, Jackie follows, and Theanne. There are the four of them, kicking like bugs, without ever having had suggestion to do so at the moment from any adult.

The above instances could be multiplied many times over, but it is felt that those cited are sufficient to show the interest and the eagerness and delight evidenced by the children in carrying on posture activities in an informal, nondidactic way.

CONCLUDING STATEMENT

An experiment was undertaken to incorporate a posture program freely into the daily activities of a nursery school, without set forms or times for the work. Equipment already in the nursery school was utilized and a few very inexpensive and simple additions or changes were made. Activities already current in the nursery school were utilized or encouraged in slightly modified form so as to fit in with postural needs. Development of specific muscle groups were aimed at throughout.

Broadoaks School of Education
Whittier College, California

Children's Feeding Problems in Relation To the Food Aversions in the Family

DOROTHEA McCARTHY

Fordham University

PROBLEM

ALTHOUGH the fundamental importance of psychological factors in feeding problems is quite generally emphasized in the literature, a rather careful search has failed to reveal any studies presenting data on possible causative psychological factors. Most of the psychological causes to which feeding problems are attributed are inferred from successful remedial training measures. Practically no quantitative data seem to be available on the problem in the home situation or on the influence of the food habits and attitudes of others in the household on the feeding habits of the child.

The present study was undertaken to investigate the food preferences and aversions of a group of young children, and to determine their relationships to food aversions among members of their families. In an attempt to throw light on some of the psychological factors underlying children's feeding problems attention has been devoted to: 1) the kinds of food offered to a group of feeding problem cases and to a similar group of normal eaters; 2) the kinds of food most frequently liked, disliked and refused by each group and the frequencies of these attitudes in each group; 3) the relation between age and attitude toward food; 4) the frequency of identical child and family food dislikes; and 5) frequencies of identical child-parent and of identical child-sibling food aversions.

Subjects

The subjects were 48 children between the ages of two years no months and seven years six months. The mean age of the group was 52.8 months. All of the children were either enrolled in the nursery school at the University of Georgia at the time of the study, or had previously attended the nursery school, or were the siblings of present or former members of the nursery school group. The subjects represent a highly selected group, coming almost entirely from professional and upper-class business homes. The 48 children came from 34 different families, there being 3 from one family and nine pairs of siblings. Twenty-one were boys and 27 were girls.

Fourteen of these children constituted a "feeding problem group," either because they were so classified by their mothers, or because of the prominence of feeding problems in

the histories of the cases as known to the nursery school. This is not an unduly high proportion of the total group to present feeding problems at these ages as judged by the reports of Maclay (3), who found 40 per cent, and Aldrich (1) who found 16 per cent of similar groups presenting such problems. In the feeding problem group there were 6 boys and 8 girls who averaged 58.6 months of age. The remaining 34 cases, 15 boys and 19 girls, averaging 50.4 months of age constituted the non-feeding problem group.

Method

The data for this study were secured by interviewing the mothers to determine whether the children liked, were indifferent to, disliked but ate, refused, or were not offered each of 72 foods. The mothers were also asked with regard to each food whether any members of the immediate household disliked or refused it. Excellent cooperation was secured from all informants.

The 72 foods considered represented an arbitrary sampling of foods commonly served in the locality, and necessarily included some items peculiar to the Southern diet. The major groups of foods with the number of items in each group were:—breads 5, cereals 6, desserts (exclusive of fruits) 7, eggs 5, fruits 14, meats (including fish) 7, dairy products (exclusive of eggs) 5, and vegetables (including rice and macaroni served as vegetables) 23. Meats were not listed according to different methods of preparation, and only one entry was made for fish. Eggs, however, were listed according to five methods of preparation, and some of the commoner fruits were listed both raw and cooked. While this may have tended to weight certain foods too heavily, and others may have received inadequate weight, it does not affect comparisons of the two groups of subjects.

RESULTS

A. *Feeding practices.* Of the 72 foods listed, on the average 85 per cent were offered to the total group, 84 per cent to the non-feeding problem group and 88 per cent to the feeding problem group. The tendency for the feeding problem group to be offered a slightly greater variety of foods than the non-problem group appears in the cereal, and dessert categories and was especially marked in the case of the dairy foods. Wide individual variations were found in the feeding practices, some children being offered all, and some only 40 per cent of the foods listed. As would be expected, there was a noticeable tendency for the younger children to be offered less variety than the older children, the rank order correlations between age and percentage of listed foods offered being .63 for the entire group, .66 for the non-feeding problem group, and .57 for the feeding problem group. This appears to be due chiefly to the tendency to omit meats and raw fruits from the diets of the younger children.

A qualitative consideration of the feeding practices as indicated by the kinds of foods offered to markedly different percentages of the feeding problem and non-feeding problem groups seems to indicate a tendency to allow the problem group more

carbohydrates, particularly biscuits, white bread, grits, macaroni, cake, candy and pastry as well as more meats, especially lamb and pork. Parallel with this may be noted the less frequent offering of several fruits generally considered to be more laxative, but the frequent use of bran, probably as a corrective. Striking contrasts which appear between the two groups regarding chocolate-milk and buttermilk are possibly indicative of efforts on the part of the mothers to tempt the children in the problem group to drink milk in some other form when difficulties were encountered with plain milk. It is also possible that the children who have known chocolate-milk are less satisfied by ordinary milk.

TABLE 1

Mean number of items in each attitude category

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Like	50.2	38.8	47.7
Indifferent	6.7	12.9	8.5
Dislike	1.6	3.5	2.2
Refuse	1.7	5.0	2.6
Not offered	12.0	9.0	11.0

B. *Attitudes toward foods.* For each child the numbers of items which he liked, was indifferent to, disliked or refused were determined. The number of liked items as reported by the mothers ranged from 9 to 68 out of a possible 72 with a mean of 47.7. (See table 1.) The number of indifferents for individual children ranged from 0 to 61 (mean 8.5) with only the one extreme case above 19. Dislikes and refusals were relatively infrequent for all children. The number of dislikes ranged from 0 to 9 with a mean of 2.2 and the refusals from 0 to 20 with a mean of 2.6.

The first two columns of tables 1 and 2 indicate sharp contrasts between the two groups of children in all four of the attitude categories. The non-problem group liked 83 per cent while the problem group liked only 66 per cent of the offered foods. The problem group was indifferent to 20 per cent of the offered foods, this being nearly twice as great a proportion of indifference as among the non-problem cases. The same tendency is to be noted among the dislikes and refusals, there being twice as many dislikes, and nearly three times as many refusals on the average in the problem group as in the non-problem group.

TABLE 2

Percentage of offered items in each attitude category

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Like	83	66	78
Indifferent	11	20	14
Dislike	3	6	4
Refuse	3	8	4

Table 1 indicates that there is practically a one-to-one relationship between the number of items disliked but eaten and the number of refusals in the non-problem group, while in the feeding problem group there were almost half again as many items refused as were eaten although they were disliked. Identification of individual cases presenting marked excesses of refusals over dislikes revealed cases

in which there was poor discipline in the home and where the child ruled rather than the parent in a variety of situations. This manifestation in the feeding situation is perhaps only one symptom of inappropriate disciplinary methods on the part of the parents of children in the problem group.

The relative popularity of the various food groups may be seen in table 3 which shows the percentages of offered items in each attitude category by food groups. For the combined groups of children, cereals, eggs and vegetables were the least liked food groups while fruits were most liked, followed closely by meats, desserts and dairy foods. Inspection of the percentages falling in each attitude category for the two groups for each food item did not reveal any possible generalization regarding differences between the two groups in the kinds of food preferred.

TABLE 3

Percentage of offered items in each attitude category by food groups

	LIKE			INDIFFERENT			DISLIKE			REFUSE		
	NP	FP	All	NP	FP	All	NP	FP	All	NP	FP	All
Breads	86	64	80	13	33	19	1	1	1	0	1	1
Cereals	80	58	71	14	30	19	2	9	5	3	11	6
Desserts	92	68	85	7	20	11	1	7	3	1	5	2
Eggs	74	60	70	18	16	18	1	2	1	7	22	11
Fruits	92	76	88	6	16	9	1	2	1	1	5	2
Meats	90	73	85	10	21	13	0	0	0	1	5	2
Dairy Foods	89	74	84	3	13	7	3	10	5	4	3	4
Vegetables	75	63	71	16	19	17	6	8	6	4	10	6

A marked tendency toward fewer likes and more dislikes in the problem group appears on almost all food items listed. All but nine items were liked by a greater percentage of the non-problem group than of the problem group. Five of these reversals were differences of less than 5 per cent. Most of the differences in favor of the non-problem group were appreciable, and even with the small numbers of cases involved here, are probably significant, many exceeding 20 per cent and several of them being as great as 50 or 60 per cent.

The individual items again show clear differentiation between the two groups in the percentages of children in each group who are indifferent to them, there being much more indifference among the problem children Reversals in this trend occur on eleven of the seventy-two items. The dislikes and refusals, as already indicated, were infrequent and scattered in both groups. In all but 12 of the 72 items, however, dislikes were more frequent among the problem children. In the refusal category, only 8 items showed reversals of the general tendency toward more refusals among the problem group.

C. *Relationships of attitudes to age.* Rank order correlations computed between age and the percentage of offered items falling in each of the

attitude categories are shown in table 4. For the group as a whole there appears to be a growing indifference to foods with increase in age (rho = .52) possibly indicative of a general dulling of appetite or of a tendency for older children to express their indifference toward food more freely. There are low negative correlations between age and the percentages of offered foods that are liked, disliked and refused by the group as a whole. The 4 correlations considered together seem to indicate a tendency away from strong preferences and strong aversions with increase in age, and a growing indifference toward food in general. These trends are more striking in the feeding problem group where a correlation of .81 is found between indifference and age as compared with only .32 for the non-problem group. For the problem group, the negative correlation between percentage of liked items and age is much more marked (rho = −.51) than in the non-problem group where it is only −.10. For refusals, the correlations are −.31 and −.02 for the two groups respectively. It cannot be determined from the data at hand whether the cumulative physiological effect of the types of feeding practices prevalent in the problem group noted above might result in this growing attitude of indifference, but investigation of this matter from the physiological point of view should prove fruitful.

TABLE 4

Rank order correlations between age and attitudes toward food

PER CENT OF OFFERED ITEMS THAT ARE	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Liked	−.10	−.51	−.22
Indifferent	.32	.81	.52
Disliked	−.14	−.07	−.16
Refused	−.02	−.31	−.11

D. *Relation of child's food aversions to aversions in the family.* It is frequently implied, particularly in the clinical literature, that children's food dislikes have their origin in the example and suggestion of other members of the family, especially those of parents and of older siblings. These implications are usually based on the generally admitted power of suggestion and example, and on the citation of isolated instances of identical dislikes among members of the same family. While the data of the present study are rather meagre, they offer some suggestive evidence on the frequency of identical food dislikes on the part of children and members of their families, particularly on the relative frequencies of identical child-parent and of identical child-sibling food aversions.

Because of the small number of dislikes and refusals throughout the data, these two categories have been combined for purposes of this analysis, the results of which are shown in table 5. It appears that the mean number of dislikes plus refusals among the feeding problem cases is over twice as great as among the non-problem cases. It will be seen, however, that there are on the average slightly fewer dislikes and refusals among members of the families of the feeding problem group than in the families of the non-problem group. This difference, while not large, is interesting in that it is in the reverse of the direction that would be expected if example of others

were the principal cause of food dislikes in the problem group. The problem group then, is not characterized by poorer eating habits in the family as measured by the number of aversions here revealed.

It may also be seen from table 5 that the dislike of a certain food by some member of the family is apparently a rather frequent reason for its not being offered to the child. There is a tendency for those items not offered to parallel the mother's dislikes more closely than those of the father or siblings. This tendency to fail to offer children foods which are disliked by someone in the family is nearly twice as great among the non-feeding problem cases as among the feeding problem cases. This may indicate that mothers of the problem cases are more concerned about the diets of their children, or take greater pains to offer variety in order to tempt the children who have poor appetites, or perhaps they more frequently allow substitutions for disliked foods.

In the feeding problem group 47 per cent of the foods disliked or refused by some member of the family, but which were offered to the child, were also disliked or refused by him. The corresponding percentage for the non-problem group is only 27. Children in the feeding problem group liked only 38 per cent of the offered items to which some member of the family had an aversion, while those in the non-problem group liked 57 per cent of such items. It would seem from these comparisons that family food aversions probably have a rather strong influence, and that they are more likely to have an adverse influence on the eating habits of children in the problem group. The two groups

TABLE 5

Various relationships between child and family food aversions

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Mean number dislikes plus refusals per child	3.3	8.4	4.8
Mean number family dislikes plus refusals per child	7.2	6.4	7.0
Per cent of items D or R by family not offered child	32	17	28
Per cent of items D or R by family but offered child			
Which are also D or R by child	27	47	33
To which child is indifferent	16	15	15
Which child likes	57	38	52
Per cent of items D or R by child which are:			
Also D or R by someone in family	41	30	35
Not D or R by anyone in family	59	70	65
Per cent of items which child D or R in common with someone in the family that are in common with:			
Adults but not with sibs (only children omitted)	27	21	24
Sibs but not with adults (only children omitted)	73	79	76
Per cent of items which child likes which are D or R by someone in the family	6	5	5

were indifferent to about the same percentage (15 per cent) of the items disliked or refused by others in the family. It would be interesting to know how many of these so-called indifferences are the beginnings of real aversions, and to what extent the failure to like these items is determined by the unfavorable attitude of others toward them. The group as a whole liked about one-half of the offered foods disliked by someone in the family, disliked or refused about one-third of them, and were indifferent to the remainder.

A further analysis of these data was undertaken using the total number of child dislikes plus refusals as 100 per cent instead of the number of family aversions as in the above analysis. This treatment revealed that in the problem group 30 per cent of the child's food aversions are paralleled by identical aversions on the part of some member of the family, while the corresponding percentage for the non-problem group was 41. In the problem group, 70 per cent of the items disliked by the children were not accompanied by similar aversions in the family, while only 59 per cent of the items were not so accompanied in the non-problem group. These figures indicate that children in the problem group had more dislikes and refusals that were unique or peculiar to them, and which were not attributable to the attitudes of others in the family, than did those in the non-problem group. Considering the combined groups, it appears that about one-third of the children's food aversions are identical with, and may conceivably be due to, those of someone in the family, and that two-thirds of them must be attributed to other factors than the example of the eating habits of members of the family.

Another question of interest in this analysis is whether children are more likely to be influenced in their food preferences and aversions by their parents and other adults in the household or by their siblings. Since about one-third of each group were only children or had only infant siblings, and hence could not have any identical child-sibling food aversions, these cases were omitted in this analysis. For the remaining cases it was found, as shown in table 5, that only 24 per cent of the items which the child dislikes in common with some member of the family are identical with the dislikes of adults only, and that 76 per cent of them are identical with the aversions of siblings. The proportions of identical child-adult and identical child-sibling aversions are about equal in the two groups of subjects. These data indicate a rather marked tendency for children to be influenced in their attitudes toward food more strongly by other children than by adults in the family.

This finding of more frequent identical food dislikes among siblings than between child and adult members of the same household is in harmony with the finding of Jones (2) that social imitation is most effective among individuals of similar ages. It is probably also one of the major reasons for the rather uniformly high degree of success of nursery schools in dealing with feeding problems, since they represent a situation in which opportunity for favorable example in eating

habits is afforded from other children of similar age.

SUMMARY

While the following conclusions hold only within the admitted limitations of this study, they may be summarized here as suggestive trends evidenced by the above analyses.

1. The feeding practices in the group of feeding problem cases differed strikingly from those in the non-feeding problem cases, the former receiving greater variety of foods and being offered many of the carbohydrate foods in larger percentages of cases than the latter. Parallel with this is the more restricted use of eggs and of fruits in the feeding problem group, the latter usually being considered more laxative and more stimulating to the appetite.

2. The problem group showed a much lower percentage of liked foods, and a much higher percentage of foods to which they were indifferent and which they disliked or refused than did the non-problem group. These differences in attitude in the two groups appeared not only for the total list and for the major food categories, but on an overwhelming majority of individual food items as well.

3. No significant generalization seems possible regarding the kinds of food preferred by the two groups.

4. Correlations with age indicate a growing indifference to food in general and a tendency away from strong likes and strong aversions with increase in age, this trend being much more evident in the problem group than in the non-problem group.

5. Food aversions on the part of members of the family are associated with about 35 per cent of children's food aversions. The problem group showed greater similarity to the attitudes of others than the non-problem group although they had no more unfavorable example set them. In addition they had a larger number of aversions that were unique or peculiar to them.

6. There was a much higher percentage of identical food aversions among siblings than between children and parents in both groups.

REFERENCES

1. Aldrich, C. A.: The prevention of poor appetites in children. Mental Hygiene, **10**, 1926, 701–711.

2. Jones, M. C.: The elimination of children's fears. J. Exper. Psy., 1924, **7**, 382–390.

3. Maclay, E.: A study of the prevalence of lack of appetite in one hundred preschool children. Unpublished Master's thesis. Univ. of Chicago, 1924.

A Research in Adolescence

The Social World of the Adolescent[1]

HEDLEY S. DIMOCK
George Williams College, Chicago

WE REPORT in this article an attempt to understand the social life and development of the boy as he passes from pre-puberty to post-pubescence by studying the activities in which he engages at successive age levels from twelve to sixteen. An objective picture of the adolescent's social world was secured by enumerating the things he actually does and analyzing the amount of time devoted to them. This procedure is definitely limited in its possibilities, of course. It needs to be supplemented by the kind of information which will illuminate the inner world of the adolescent; his attitudes, motives and desires, his ambitions and frustrations, his conflicts, doubts, and worries.

It is possible, however, to learn something about the characteristic development of the boy during adolescence by observing and recording in systematic fashion what he does and the amount of time he devotes to the various types of activity which enter into his course of living. What a person actually does is certainly an essential part of his life as well as the motives of his conduct or the way he *thinks* or *feels* about what he does. We take it for granted that the sixteen-year-old-boy, in comparison with the twelve-year-old, sleeps less, studies more, and is more likely to do some remunerative work in his out-of-school hours. If we knew in a fairly accurate fashion all of the things which the boy does at sixteen and the amount of time they occupy and then compared these facts with those for the pre-pubescent boy, we would have an objective and enlightening—even though crude—index of what takes place in the maturing of the adolescent. We at least would know more definitely what phases of the wider community environment impinge most directly and most frequently upon the growing boy. Changes in the individual should also be registered or reflected in the changes in his overt behavior.

Through a procedure to be described more fully later we were able to secure a *time-activity analysis* for the boys in the study. A complete account of everything done from morning until night, with the amount

[1] This is the second article in a series, the first of which appeared in the September issue of *Child Development*. The major characteristics of this study of two hundred adolescent boys are outlined in the preceding article.

of time devoted to each activity for a period of a week, was secured annually from each of the two-hundred boys. The resulting data, after being classified, compiled, and analyzed, furnish a sketchy outline of the social life and world of the adolescent boy at successive ages, as reflected in his overt activities.

More specifically, the questions which material in this chapter help to answer on a factual basis include the following: (1) How does the adolescent boy spend his time in the current community? What constitutes a typical week for boys at the various ages from twelve to sixteen? How is their time divided among recreational, school, work, and club activities? (2) What does the distribution of time devoted to the various activities reveal about the boy's social world and development? (3) What are the most important changes in activities and experiences from prepubescence to post-pubescence as indicated by changes in the disposition of time? Does the older adolescent boy spend less, or more time in physical play, club activities, reading, study, amusements, etc.? (4) At what age do the most marked changes in social activities as registered in the amount of time devoted to them seem to take place? (5) Is there an overcrowding of the time of the adolescent boy and an overlapping of the agencies which seek his leisure-time loyalty?

TECHNIQUE OF THE TIME-ACTIVITY ANALYSIS

The technique employed for securing the desired information was a combination questionnaire—interview. Some studies had used a questionnaire schedule on which the subjects recorded their activities daily for a period of a week. We doubted the desirability of using this device, as a more adequate control of the reporting process seemed essential for our purpose. It would have been desirable to have the boys report daily to the field workers and fill out a schedule for the preceding twenty-four hours, but this was impracticable.

The procedure finally adopted and utilized throughout the study was as follows. The field workers secured from each boy in the study through an interview, on a carefully prepared schedule, a complete record of: (1) all of the things done by the boy each day for a week from rising until retiring; (2) the amount of time spent in each activity; (3) the persons with whom he engaged in each of these activities; and (4) a list of the boys he knew best ranked in the order of his preference for them. This companionship material provides the basic data for articles to appear later.

A great deal of thought and preparation was required on the part of the field workers to motivate the interview so that the boys would respond with the fullest confidence, coöperation, and frankness. In the course of the three years, in which approximately six hundred interviews took place, very little evidence of irresponsible or uncoöperative attitudes was discernible.

The difficulty of the boy being able to recall his activities for an entire week with accuracy and completeness was fully recognized. Two systems of securing the report from the

boys were tried out in order to determine the better procedure. In the first one, the boy was requested to start a week back and report his activities daily for the intervening period. In the second plan, the boy started with the activities of the preceding day, or the same day if the interview took place at night, and worked backward day by day. The second procedure was distinctly superior in the judgment of the interviewers and their opinion was supported by a comparative study of the filled-in schedules. When the first procedure was used the boys had considerable difficulty in recalling with accuracy and detail the activities of the earlier days in the week period. Consequently the records for these days tended to be more fragmentary. When the procedure was reversed, the more recent experiences of the boys were readily recalled and these tended to stimulate the recall of activities of the preceding day.

A few additional comments about the interview technique may help to answer some of the questions which readers are likely to raise. The interviewer recorded the information himself, partly for purposes of legibility, uniformity, and economy of time, but more particularly to be able to control inconspicuously the completeness and consistency of the report. The interviewer also attempted to get a check on the typicalness of the week reported. For example, if the boy reported attending two movies in the week a question as to whether this was the usual thing or not would secure an answer that would help to correct any marked discrepancies from the customary activity. Immediately after the interview, which usually occupied more than an hour, the interviewer recorded on a part of the schedule provided for this particular purpose his judgment about: (1) the accuracy of the information received; (2) the typicalness of the week reported, and any important deviations from the boy's usual program; (3) the boy's reactions to, and behavior during the interview; and (4) "leads" for further study. This additional information was not only valuable as part of the *time-activity study* but contributed some valuable material toward the more complete case study of each boy.

These comments on the interviewing and recording procedure are the more important because the reliability of this technique was not determined as it would be for a standardized test. There did not seem to be any simple way to establish the reliability of such an instrument. The dependability of the data rests largely, therefore, upon the precautions taken to secure accurate information and upon the evidence of consistency within the material of each interview. An additional check-up on reliability is the extent to which the total results correspond to observation at points where it is most likely to be trustworthy. For illustration, it is a matter of common knowledge that boys sleep less as they get older. The results of the *time-activity schedule* agree so thoroughly with the commonsense expectations that they give indirect evidence of the reliability of the procedure. This kind of evidence is precarious of course. Some of the

results run counter to common expectations but we infer that these findings are essentially reliable even when they contradict common belief. If the *time-activity schedule* is not interpreted as a test but as an interview technique as described, yielding rough data, we feel justified in believing that the results in general show trends which may be relied upon.

TABLE 1

Average hours per week spent in various activities by boys twelve to sixteen years old

ACTIVITY	AGE					CHANGE FROM 12 TO 16 YRS.
	12	13	14	15	16	
	Number of boys					
	30	61	83	53	22	
I: Home activities:						
1. Sleep	74.1	72.0	70.2	68.7	69.2	−4.9
2. Eating	8.8	8.3	7.4	7.1	6.8	−2.0
3. Reading	6.2	5.4	6.5	6.2	5.0	−1.2
4. Entertainment	5.4	7.3	5.5	6.0	6.5	+1.1
5. Chores	2.7	3.3	3.4	3.0	2.5	−0.2
6. Routine	2.6	2.9	2.8	2.9	2.8	+0.2
7. Study	1.3	2.5	2.9	4.1	4.8	+3.5
8. Miscellaneous	3.0	2.5	2.3	2.3	2.0	−1.0
II. Community activities:						
1. Classes	24.1	24.7	24.2	26.5	26.3	+2.2
2. Physical play—participant	10.5	9.6	7.7	6.9	6.7	−3.8
3. Travel	9.6	10.1	10.2	11.4	12.5	+2.9
4. Amusements	6.8	5.9	7.5	6.8	6.0	−0.8
5. Work	3.3	2.7	3.9	4.8	5.2	+1.9
6. Physical play—spectator	0.7	1.2	1.4	1.1	2.0	+1.3
7. Club	2.0	1.7	1.5	0.7	0.2	−1.8
8. Miscellaneous	7.2	7.8	10.2	9.4	9.5	+2.3
Total	168.3	167.9	167.6	167.9	168.0	

THE ACTIVITY WORLD OF BOYS TWELVE TO SIXTEEN

Table 1 tells a comprehensive and illuminating story. The average hours per week spent in various activities by boys at each age from twelve to sixteen years are shown. Table 2 presents the same facts but on the basis of per cent of time rather than amount of time. A few of the activity categories may need to be defined before the meaning of the results can be most readily grasped. The category *reading* is used for voluntary reading only, as reading done in relation to school work is classified under *study*. Entertainment includes the things of an amusement nature, apart from reading, which are done in the home, such as card playing and listening to the radio. Riding with parents in an automobile is arbitrarily included in this category. Under

routine we have included such items as dressing and washing. *Participating in physical play* is separated from being a *spectator* of sports and games in order that these two quite different sorts of activities could be studied independently. Under *amusements* were grouped all of the extra-home amusements except the physical activities which were participated in or watched. *Club* activities were excluded from this category chiefly because we wanted to observe them as a distinct kind of leisure-time activity. The *travel* category covers all of the time taken in going to and coming from school, work, amusements, etc. The *miscellaneous* category, both in the home and the community lists, really covers everything that did not belong in any of the other categories. In the home it includes such things as: practicing or playing music, just chatting, working on a hobby interest, etc. Similarly, in the community it takes in a variety of things, such as chatting, visiting, attending Sunday school or church, etc.

The facts represented in tables 1 and 2 and the figures which follow throw valuable light on what boys do in a typical week at various ages and on the major shifts which take place in this activity world from the years twelve to sixteen. We shall look first at the typical activity world of the boy at different age levels as revealed by these results.

TABLE 2

Percentage of time per week spent in various activities by boys twelve to sixteen years old

ACTIVITY	AGE					CHANGE FROM 12 TO 16 YRS.
	12	13	14	15	16	
Sleep	44.3	42.9	42.0	42.0	42.3	−2.0
Classes	14.4	14.7	14.4	15.8	15.8	+1.4
Participant in physical play	6.3	5.8	4.6	4.1	4.0	−2.3
Travel	5.7	6.0	6.1	6.8	7.5	+1.8
Eating	5.0	5.0	4.5	4.2	4.3	−0.7
Miscellaneous—community	4.3	4.6	6.1	5.6	5.7	+1.4
Reading	3.7	3.3	3.9	3.7	3.0	−0.7
Amusement—community	4.1	3.5	4.5	4.1	3.6	−0.5
Entertainment—home	3.2	4.3	3.3	3.6	3.9	+0.7
Work	2.0	1.6	2.3	2.9	3.1	+1.1
Chores	1.6	2.0	2.0	1.8	1.5	−0.1
Routine	1.5	1.7	1.7	1.7	1.6	+0.1
Miscellaneous—home	1.5	1.5	1.4	1.4	1.2	−0.3
Club	1.5	1.0	0.9	0.4	0.1	−1.4
Study	0.8	1.5	1.7	2.4	2.9	+2.1
Spectator of physical play	0.4	0.7	0.8	0.7	1.2	+0.8

Typical Week of the Twelve-Year-Old

Fifty-nine per cent of the twelve-year-old boy's week is taken up with sleep and classes, leaving considerably less than half of the boy's week for leisure-time activity. The very small

amount of time spent in study and in club activities may be surprising to some. When the time devoted to entertainment in the home, to amusements outside of the home, and to physical play as participant and spectator are added together we find that over twenty-three hours per week are utilized for purely recreational purposes. This just balances nicely the amount of time spent in school. If we add the six hours per week used in reading "just for fun," over 30 per cent of the boy's waking hours are spent in these four types of recreational activity.

A day's program of activities taken directly from an interview schedule has the value of being concrete, though it may not be very illuminating. We reproduce it, however, chiefly because it illustrates the technique of the *time-activity schedule* better than any explanation could do. The day's schedule which appears below is a typical one. It is reproduced just as it appears on the record without any editorial polishing except the obscuring of names.

Sample of a Day's Activity Schedule for Twelve-Year-Old Boy

Day	*What did you do?*	*With whom?*
Wednesday		
7:30– 8:00	Breakfast—Read Ted Scott—*Flying Against Time*	Nobody
8:00– 8:30	Played football	Named 8 boys
8:30–10:15	Classes at School	38 boys and girls
10:15–10:30	Recess—Played Pom Pom Pullaway	Same boys as for football
10:30–12:15	Classes at School	Same 38 boys and girls
12:15–12:30	Walked Home	Charlie S.
12:30– 1:00	Had Dinner—Read—*Beasts of Tarzan*	Mother
1:00– 1:30	Played football	Same 8 boys as above
1:30– 3:30	Classes at School	Same 38 boys and girls
3:30– 4:30	Played—Chasing a kid who called names	I. S. and B. M.
4:30– 5:00	Ransacked two of dad's old desks, getting clips, etc.	Alone
5:00– 6:30	Supper	Mother, dad, two brothers, 16 and 19, two sisters, 20 and 7
6:30– 7:00	Read—*On the Trail of Washington*	Alone
7:00– 8:45	Went to Library	H. R. and D. W.
8:45– 9:00	Read—*Pirate*	Alone
9:00	Went to bed.	

In studying and interpreting these findings concerning the activities of the boys, a most significant fact should not be overlooked or minimized. In the main we have used averages in the figures because we are seeking major tendencies and generalizations. But there are two very important limitations in using averages. First, the average is an abstraction; there are no actual individuals who correspond to it. Secondly, the use of averages tends to mask individual differences. The exceptions to average trends are also important, both in themselves

and as a source of investigation and discovery.

With this statement about the significance of the variations from the abstract average we shall proceed by describing a typical week of a synthetic twelve-year-old boy in concrete fashion. We recognize, of course, that no individual boy will actually fit the "synthetic" picture, from the standpoint of either the particular, or the diversity of, activities included in the synthesis.

On school days our "synthetic" twelve-year-old gets up about seven or seven-thirty in the morning. He may read, practice his music, or play outside for a while before breakfast. He walks to school, unless he is one of the few who attend high school, when it may be necessary for him to ride. He usually walks with one or more of his boy friends who live near him. At recess he probably plays whatever athletic game is seasonal or some more informal type of game. He walks home at noon, hastily eats, and either reads for a little while, or hurries back to school, generally to get in a half hour of active physical play before classes begin again.

After school the activities of our "synthetic" boy are so diverse that they are hard to put together. About half of the boys play until the evening meal. About twenty-five per cent of them do some kind of remunerative work, delivering newspapers being the most common. Many of the boys spend this time in taking or practicing music lessons, reading, working on some hobby, or "just fooling around." After the evening meal with the family there is likely to be another period of play out-of-doors, either of the seasonal variety of sport, or of such informal games as chase, tag, and hide. The rest of the evening is usually spent at home, reading books, newspapers or magazines, or in some form of entertainment, as listening to the radio. Little time is spent on school work at home. Forty per cent of the boys report no time at all spent on home study, but a few average nearly an hour a day. This is less a matter of age, of course, than of the requirements set by the boy's particular grade in school. A small per cent of the boys attend movies occasionally through the week, but for the majority Saturday or Sunday are the movie days. Two-thirds of the boys belong to some type of club for boys, Scouts, Church, or Y.M.C.A. For them, there is one evening meeting a week, more often on Friday than any other night. We may interject here that two years later, only 25 per cent of these same boys report any club activities whatever in their week's schedule. Bed comes anywhere from nine to ten o'clock.

The week-end program, on Saturdays and Sundays, varies greatly with the boys. Saturday morning typically seems to include a later sleep than usual, whatever chores or errands are to be done, and a little time for play or reading. In the afternoon, more play with the fellows, perhaps a movie, visiting back and forth with friends, some work on achievement tests for Scouts, or perhaps a hike or other activity with the troop or club. Saturday evening may bring a car ride with the family, or a

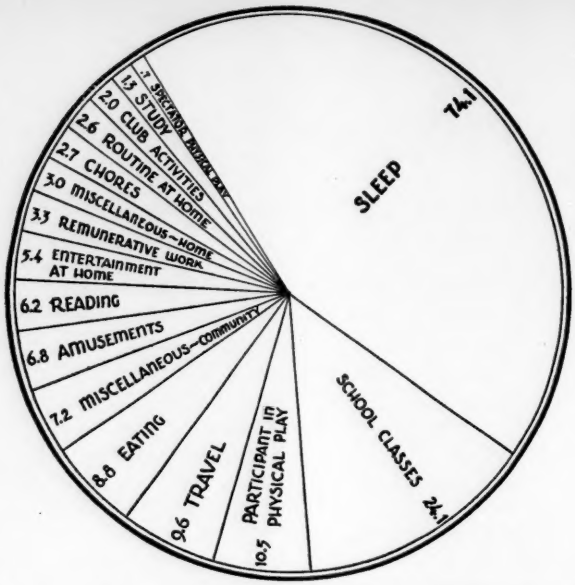


FIG. 1. AVERAGE HOURS PER WEEK SPENT IN VARIOUS ACTIVITIES BY TWELVE-YEAR-OLD BOYS

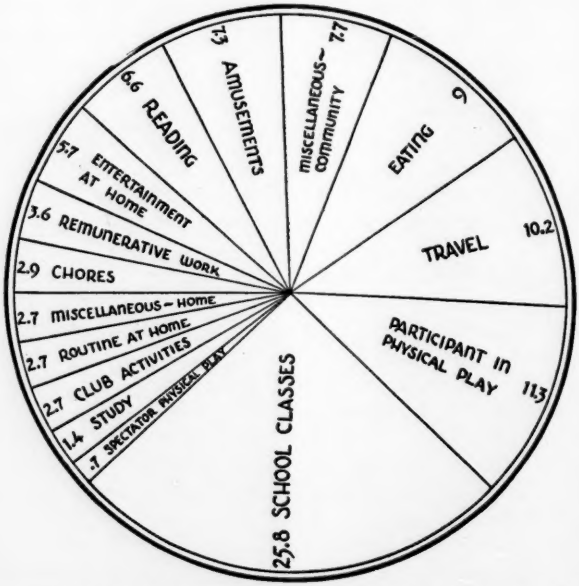


FIG. 2. PERCENTAGE OF TIME PER WEEK SPENT IN VARIOUS ACTIVITIES BY TWELVE-YEAR-OLD BOYS (EXCLUSIVE OF SLEEP)

movie, or more play with the crowd, or possibly the time is spent at home with the radio or in reading. Comes another late sleep on Sunday, then Sunday School for more than half of the boys and church service for a few. Reading the Sunday paper, especially the "funnies," is a general practice. Many of the boys also get in some play with their friends in the morning. In the afternoon and evening there may be a visit from, or to, friends or relatives, often a car ride, but more often a movie.

Such a description of the "synthetic" twelve-year-old may do little more than provide a factual basis for impressions and knowledge which are commonplace to the observers of boys. It gives us only the skeleton of the social world of the twelve-year-old. But it does show us the framework of activity and experience within which the development of the adolescent personality takes place.

Figures 1 and 2 show in graphic manner the time devoted to the various categories of experience at the age of twelve. Figure 1 is based on the average hours per week spent in the activities, figure 2 is based on the percentage of time per week spent in the activities.

Typical Week of "Synthetic" Sixteen-Year-Old

We shall now attempt to portray in descriptive fashion the social world of the "synthetic" sixteen-year-old boy. We can perhaps accomplish this task with more brevity and discrimination if we indicate particularly the points at which it differs most from the activity world of the boy of twelve previously described. Later we shall present in graphic style the data indicating quantitatively the shifts in activity from the twelve- to the sixteen-year level.

The sixteen-year-old boy gets up a little earlier than the younger boy, chiefly because he has farther to go to school. Like the twelve-year-old boy he arrives at school early enough to play, watch others play, chat, or study for a little while before classes begin. At recess he is more likely than the younger boy to be found around the halls or outside talking or "fooling around" with some girls along with some other boys. After school he is a little more likely than the twelve-year-old to have some remunerative job such as selling or delivering papers. If not, he may stay around school to play football, basketball, or baseball, or to practice for track athletics, but unless he is "trying out for the team" he is more likely to be found watching the team practice or play. Quite a large number of boys spend some time during the afternoon reading at home, or in listening to the radio.

We find two or three new tendencies in the evening program of the sixteen-year-old. He is more likely to do something outside of the home, play or visit with friends, go to a movie, or go riding in the car. He is much less likely to attend any organized club activity. Unless he is a patrol leader the chances are slight that he will still be a member of a Scout troop. Neither is he likely to attend club meetings at the church or

Y.M.C.A. Many boys generally spend the evening at home, listening to the radio, reading, perhaps playing pool, checkers or ping pong, and quite often studying.

The activities of the sixteen-year-old boy on Saturday and Sunday are not substantially different from those of the pre-adolescent. On Saturday morning he enjoys a late sleep unless he has a paper route or similar responsibility, does a few chores or errands, and plays or reads for a short time. His afternoon program varies in detail with the season, but its general motif is athletic participation for a few, the spectator rôle for many more, and the spectator rôle via the radio for a large number, especially in the football season. Attending movies, usually with one or more boy friends, is also a common Saturday afternoon event. One new feature is occasionally included in the week-end program. That is the mixed "party," which occurs most frequently on Friday or Saturday night. The mixed party, on anything like a regular basis, is still an affair for the minority, however. For the majority, Saturday night means a show; or just hanging around with the crowd; or reading, playing cards or other games, or listening to the radio, at home.

The sixteen-year-old is less likely to attend Sunday school than the younger boy, but somewhat more likely to attend the adult church service. The rest of the day is used for reading, car riding, a "date" for a few boys, movies for many, listening to radio programs, a little study, and visiting or being visited by friends or relatives.

SHIFTS IN THE SOCIAL WORLD FROM TWELVE TO SIXTEEN

What are the most important changes which take place in the social world of the boy between twelve and sixteen years of age as registered in the amount of time devoted to the various kinds of activities? The answer to this question is supplied in

TABLE 3

Change in amount and per cent of time devoted to activities by boys between twelve and sixteen years of age

ACTIVITY	PER CENT OF CHANGE	RANK	AMOUNT OF CHANGE	RANK
Study	+269	1	+3.5	3
Spectator of physical play	+186	2	+1.3	10
Club activities	−90	3	−1.8	9
Miscellaneous—home	−67	4	−1.0	13
Work	+57	5	+1.9	8
Participation in physical play	−36	6	−3.8	2
Miscellaneous—community	+32	7	+2.3	5
Travel	+30	8	+2.9	4
Eating	−23	9	−2.0	7
Entertainment	+20	10	+1.1	12
Reading	−19	11	−1.2	11
Amusements	−12	12	−0.8	14
Classes	+9	13	+2.2	6
Routine	+8	14	+0.2	15.5
Chores	−7	15.5	−0.2	15.5
Sleep	−7	15.5	−4.9	1

Table 3, which shows the changes in both the actual amounts and the per cent of time spent in the various activities from the twelfth to the sixteenth year. We need to be cautious, however, in making judgments about the relative amounts of change in the different activities, since we are not dealing with comparable units.

Obviously it would be meaningless to say that there was four times as much change in the amount of time spent in sleep as in reading, though that is literally true. The units of time involved in these two activities are so disparate that such comparisons are invalid. The use of percentages shown in the first column of the table is probably more valid. The most valid unit of comparison would probably be the standard deviation of each activity. Hartshorne and May give illustrations of its effective use.[1] The chief advantage in utilizing the figure showing the change in actual amount of time is that it is more readily translated into concrete everyday terms. The statement that the boy at sixteen spends three and a half hours a week more in study than the boy of twelve can be quickly visualized in its practical setting. To state that there is an increase of 269 per cent in the amount of time spent in study from the years twelve to sixteen makes comparison with other activity changes possible, though its practical meaning is less obvious. In our further analysis and interpretation of these findings we shall consider both the actual amount and the per cent of change in the time given to the activities.

Table 3 shows, in addition to the actual amount and the per cent of change in the sixteen types of activities, the rank order of the activities on each of these two bases. The difference which results from these two methods of computation are clearly discernible. Of the first five items computed on the basis of per cent of change only one is included in the first five when the actual amount of change is figured.

Some of the more salient findings represented in table 3 merit further comment and interpretation. We shall consider first those activities to which boys devote a larger amount of time as they become older. Figure 3 displays in graphic form the changes

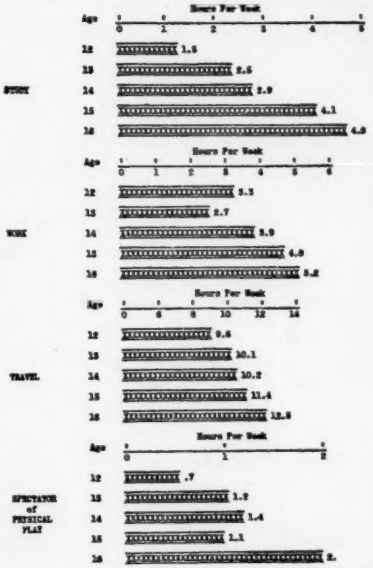


FIG. 3. AVERAGE HOURS PER WEEK SPENT IN STUDY, WORK, TRAVEL AND AS SPECTATOR OF PHYSICAL PLAY, BY BOYS TWELVE TO SIXTEEN YEARS OF AGE

year by year for the five years for some of these activities.

The increased time spent in study, travel, classes, and work is not in the least surprising. The sixteen-year-old boy spends almost four times as many hours per week in study as the twelve-year-old. This difference, due

to the change from elementary to high school, represents both *more* boys who report study and a *larger* amount of time spent in study. A small number of boys report ten to twelve hours of study a week. Quite a substantial number report eight hours. The average, it will be observed, falls slightly below five. The additional time alloted for travel reflects in part attendance at a high school but also time spent in going to and from work or amusements. The gain in time occupied by remunerative work is chiefly the result of the larger number of boys who engage in some form of work outside of school hours. All of the boys are still going to school in their sixteenth year. The larger amount of time given to miscellaneous activities in the community, about two-and-a-third hours, is the more significant when it is recalled that Sunday school and church attendance, which is included in this category, is considerably reduced by sixteen. The difference in the amount of time spent in routine at home, such as washing and dressing, is so trivial that it is insignificant. Theoretically, we might expect considerable additional time devoted to the improvement of the older boy's personal appearance as an accompaniment of his enhanced interest in girls. But twelve minutes a week would hardly do justice to a single "date."

Our attention is arrested strikingly by the fact that as the boys become older they spend an increasing amount of time as *spectators* of games and sports. If this means that the older boys are actively participating in physical activities themselves, but are also interested in watching others, perhaps more skillful than themselves, play, that is one thing. If it signifies that the older boy is becoming *less* a participant and *more* of a spectator, that means something quite different. Which of these it is we shall shortly consider.

When we examine the data for the activities in which boys spend a decreasing amount of time as they get older we find the obvious confirmed at some points and probably receive some surprises at others. As we would expect, there was a gradual reduction in time for sleep and it may be of interest to note that the number of hours of sleep at each age level measures up to the standards set by the specialists in child health. A greater tendency toward irregularity of sleeping hours as the boys become older was clearly discernible as the data were being tabulated.

The second largest shift in the time devoted to an activity is that spent participating in active physical play. This reduction is due to both a decrease in the number of boys who engage in any physical play and in the amount of participation by other boys. A few of the older boys, particularly those who "made" the school teams, spend considerably more time in these activities but this increase of time is more than offset by the reduced participation of the majority. For twenty-five per cent of the boys participation in active physical play is so slight that it is negligible. When these facts are coupled with those which indicate increase of the spectator rôle, it strongly suggests that the germ of "spectatoritis," the unex-

ercised multitude watching the over-exercised few, is already taking hold during adolescence. The "rah rah" college student who shouts vociferously for the team, and his equivalent, the chronic fan in the community, are evidently in the making in these adolescent years. These findings on participation in physical activities and in club activities might be considerably affected by local conditions.

The diminishing time used for eating may not be a matter of great consequence but it does intrigue us to inquire what it signifies. Does it suggest an accelerated tempo of life, with so many things to be done that there is a growing tendency to "grab some food and run"? Or does it chiefly mean that most of the noon meals are eaten even more hastily at school than they were at home a few years earlier? This latter possibility could easily account for a share of the two hours difference per week.

To some readers the most surprising and provocative findings reported in this article are those depicted in figure 4, showing the rapid reduction in the amount of time utilized for the activities of organized clubs or groups. Under this caption has been included participation in all such groups as Scout Troops and clubs or classes in churches, Y.M.C.A.'s, or social settlements. It includes, therefore, all of the leisure activities which are sponsored and supervised by any of the social or religious agencies of the community. Only five of the twenty-two sixteen-year-old boys report any club participation. This is a small number on which to base generalizations but the tendency toward reduced participation from twelve to sixteen is seen to be consistent from an examination of the facts displayed in figure 4. These findings might be modified in either direction, of course, by a study of similar data from other communities, since local conditions would very directly modify the extent and

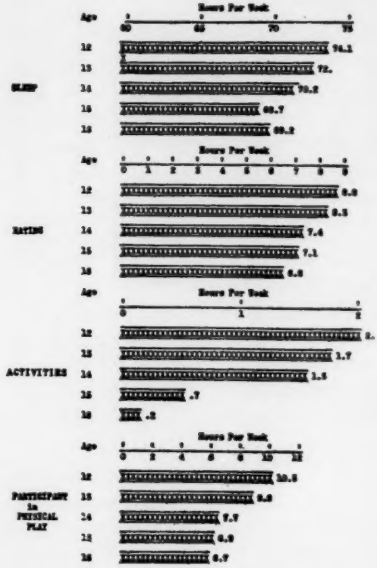


FIG. 4. AVERAGE HOURS PER WEEK SPENT IN SLEEP, EATING, CLUB ACTIVITIES, AND PARTICIPATING IN PHYSICAL PLAY, BY BOYS TWELVE TO SIXTEEN YEARS OF AGE

persistence of membership in organized groups or clubs. In one important way these findings are biased toward a larger participation record. At the beginning of the three-year study nearly all of the boys belonged to groups in one or more of the community agencies, since it was through these agencies that contact with the

boys was established. We might expect, therefore, that their participation in club activities would be *greater* than that of a totally unselected boy population. This enhances the significance of the facts disclosed even though these findings may not be typical of other or all communities in the country.

The implications of the findings on the participation of boys in club activities will be discussed in another place. A few questions, however, will be in order here. Do these facts suggest that the older boy does not need the experience, guidance, and leadership that the community assumes is provided by these agencies which conduct programs specially designed for the adolescent? Or does it mean that these agencies are not providing the kinds of program and leadership which appeal to the older and more difficult-to-satisfy boys? Facts which throw light on this apparent inability of social and religious agencies to hold their participants through the later adolescent years were secured in another phase of the study, which was focused on adolescent groups. One thing does stand out unmistakably. For the boys in this study, there is no problem of multiplicity of social agencies competing for their time and loyalty. A few of the boys belong to two organized groups. But this duplication is negligible even in the earlier years and is practically non-existent by sixteen.

ACTIVITY CHANGES IN RELATION TO AGE

A provocative question now arises. At what age do the most marked activity changes take place as reflected in the shifts in the allocation of time? Does any particular age stand out as a time when the greatest change is taking place? Our facts are too crude to yield anything like satisfactory answers to these questions but we may at least indicate the problems and the techniques which might be applied in dealing with them.

Different approaches to the answer to the question as to what age, if any, reflects the most marked changes are possible. We might ascertain the age at which the *largest number of activities* show the greatest increase or decrease in the time devoted to them. Or we might compute the amount of change in time devoted to all activities for each age period, regardless of whether it is increase or decrease, and assume that the age with the largest "change score" is the most crucial. Both of these analyses have been made.

If we select the eight activities in which change has been most substantially and consistently registered we do not discern any decisive single year period, but the earlier years from twelve to fourteen apparently register more change than any other two-year period. Table 4 indicates that for the one-year periods, five of the eight activities have their greatest change from either twelve to thirteen or from thirteen to fourteen. These differences in many cases are so slight that they are negligible, but the results may at least suggest tendencies.

For the two-year period there is a similar majority of changes in the earlier years, twelve to fourteen. The changes in time devoted to travel and club activities stand out most clearly

after fourteen. The years from twelve to fourteen seem to be more important for changes in: participating in physical play, sleep, eating, and work.

The second type of analysis, the results of which are exhibited in figure 5, shows the total amount of change in

TABLE 4

Ages at which greatest amount of change in hours spent in eight activities takes place

ACTIVITY	ONE YEAR PERIOD	TWO YEAR PERIOD
Participant in physical play.	13–14	12–14
Sleep	12–13	12–14
Eating	13–14	12–14
Study	12–13	12–14
	14–15	13–15
Travel	14–15	14–16
Work	13–14	13–15
Spectator of physical play.	15–16	12–14
Club	14–15	14–16

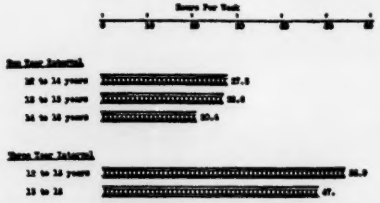


FIG. 5. TOTAL CHANGE IN HOURS PER WEEK SPENT IN ALL ACTIVITIES FOR VARIOUS AGE PERIODS

time allocation for all activities for the different year periods. The total is slightly, but insignificantly, larger for the thirteen-fourteen year period. The changes from fifteen to sixteen are substantially less marked than for any other year period. This difference is largely responsible for the periods fourteen to sixteen and thirteen to sixteen showing the least change of any of the two and three-year periods.

The major interpretation that these facts suggest is that the years twelve to fifteen consistently register more change in the development of the adolescent, as studied by this method, than does the year after the boy is fifteen. Any opinion as to whether pubescent or social factors are the most influential in these changes would be purely speculative in the absence of more accurate and detailed information. A more exact time record for a much larger number of cases, with both pubescent and social factors thoroughly analyzed, might yield fruitful evidence bearing on this problem. In the next article in this series this type of analysis of facts somewhat similar to those presented in this article will be made.

IMPLICATIONS FOR UNDERSTANDING THE DEVELOPMENT OF THE ADOLESCENT

What do all of the foregoing facts mean for our understanding of the personality and social development of the boy during the adolescent years? Our interpretative comments may be summarized around three phases of the adolescent's development. (1) The expansion of social contacts; (2) the achievement of emancipation from parents; (3) heterosexual development.

The Expansion of Social Contacts

Observation might lead us to believe that a major, if not *the* most influential, factor in the development of the adolescent is the widening of social

contacts. Theoretically, at least, it is possible to see how many changes in attitudes, interests, and behavior are conditioned by the wider and more complex set of social experiences which gradually impinge upon the boy as he gets older. Social psychologists have believed that many of the assumed characteristics of the adolescent—the new stimulus to thinking, the sharpening of moral discrimination, the conflicts in attitudes and in ideas, etc.—are primarily the result of this broader and more complex set of social factors. The wider social environment brings many contrasts to the ideas, patterns, standards, customs, and mores of childhood, and thus sets the stage for discrimination, choice, conflict, and instability.

Our concern at this point is not so much the effect of such an expanding social world upon the boy as it is the *fact and the extent* of such an expansion. What evidence comes from the analysis of the time-activity data to support or controvert the common observation that the sixteen-year-old boy's world is larger and less simple than that of the twelve-year-old?

The findings which have been reported here suggest four kinds of experience which are indicative of an expanding social world. These four are: the increase of time spent in travel, work, and miscellaneous activities in the community, and the change from the elementary school to the junior or senior high school. This latter shift usually means association with a more heterogeneous student body from the standpoint of race, socio-economic background, community factors, standards and mores, interests, attitudes, and customs. The high school also provides a wider orientation to problems of a social, scientific, and economic character through different teachers, new subjects in the curriculum, and contact with other students.

The increase of time spent in remunerative work also has implications for the enlargement of the boy's social world. We have not attempted to break down the elements of this work-a-day world in any factual way. We may assume the probability of many new elements entering his experience. There is the contact with persons, standards, values, and methods which belong to the business world. There is likely to be a new necessity or demand for responsibility and dependability. There may be a strict accountability to superiors who operate with a new type of authority and control. Relationships may be impersonal and secondary in contrast with the personal relationships of the school and the intimate relationships of the home. The boy may also find a contrast between the "ideals" he has been taught and the "realities" he now discovers.

Effects similar to these which may accompany the high school and work experience may also result from the increased time spent in travel and in miscellaneous activities in the community. These experiences are probably symptomatic of a gradual expansion and complexification of the adolescent's social world. The contact with many persons, situations, and conditions in the community, perhaps a different neighborhood from the one in which he lives, is likely to

open up not merely a larger, but a complex, if not contradictory, set of social patterns and practices. It is the *heterogeneity* in persons, customs, mores, attitudes, ideas, and behavior that comes with the wider contacts of travel, work, high school, etc., that sets the stage potentially through new stimuli and contrast for conflicts, for new attitudes and ideas, and for conduct that may be characteristic of the adolescent.

Emancipation From Parents

The expanding social world is a very definite factor in the process of the boy becoming emancipated from his parents. The central characteristics of an adult are independence and the ability of self-direction. The adolescent years are of crucial importance in this process of becoming psychologically "weaned" or emancipated from parents so that maturity may be achieved. While data directly bearing on this phase of the adolescent's development will be presented in a later article, our attention should be called here to a few implications of the *time-activity* findings for this problem.

The materials yielded by the *time-activity schedule* reveal several factors which may influence or reflect this process of emancipation from parental control. The widening social contacts are basic, of course. They signify that some areas of experience, at least, are passing more completely out of the control of the parent. Remunerative work, whether undertaken because the boy wants more spending money, or because he wants to be more independent, almost inevitably means more independence and freedom, both in relation to parents and to the many choices and decisions which the boy must make. We have noted that the daily schedule, particularly in the evening hours, is more irregular for the older boy, suggesting greater freedom in his evening programs. The slight decrease in time spent in home chores may be another indication of a changing status for the boy in the home. This exemption may be granted because of the increased time he needs for study and for work. The amount of time which the sixteen-year-old spends in the home is probably not so much smaller than that which the twelve-year-old spends as we might expect. At twelve the boy spends one hundred four hours per week in the home. By sixteen this time has been reduced by four-and-a-half hours. Two factors seem to keep the figure as low as four-and-a-half hours. The boy studies on the average three-and-a-half hours more per week at sixteen than at twelve. Further, the radio, which is a major means of entertainment at all ages, does not take the boy out of the home. Attendance at the movies is not very much more frequent for the older boy, although he probably has more freedom in the choice of *where*, and *with whom*, he goes.

The Achievement of Heterosexuality

Some students of adolescent life believe that the achievement of heterosexuality is equalled in importance as an adolescent characteristic only by the process of becoming emancipated from parents. Heterosexuality means an adult level of sexuality

in which the primary sex interest is in the opposite sex. Heterosexual experience is present on the childhood level, but the final stage in the completion of boy-girl differentiation should be achieved by late adolescence. The word "achieved" is aptly chosen because heterosexual development is not a biological gift, though it should normally receive some impetus from the biological changes of puberty. Nor can it take place in a vacuum. It develops only through relationships with the opposite sex.

The findings from the *time-activity schedule* do not permit any time-accounting for this heterosexual experience. Pertinent data are fragmentary, yet indicative. The schedules show that the recess periods at school are used much less for active play by the older boys and more for walking around the halls and chatting with other boys and girls. This may appear to be a very mild form of heterosexual behavior. It marks, however, the beginning or exploratory stage, which leads to activities which are more selective and intense. The number of definite evening "dates" reported in the interviews are few, even for the older boys, but are double in frequency those reported by the younger boys. We realize that these are very meager facts concerning such an important phase of adolescent development. They may be interpreted merely as "straws which indicate the way the wind is blowing."

REFERENCE

(1) HARTSHORNE and MAY: Studies in the organization of character. Chapters XIX–XXII.

Growth in Social Behavior and Mental Activity after Six Months in Nursery School

HELENA MALLAY

SOCIAL behavior is one of the most important aspects of the development of the preschool child. Mental activity is another. Failure to adjust socially and mentally to the environment seems to be highly correlated with emotional instability and general personality difficulties. At the present time, there is as much reason to believe that engaging in successful social behavior and constructive mental activity will automatically clear up emotional difficulties as that emotional analysis and re-education for emotional stability will result in subsequent social adjustment and adjustment in the sphere of mental activity. For this reason, greater emphasis than heretofore has lately been put on techniques for social adjustment and methods for stimulating constructive use of materials and equipment.

Furthermore, there is a growing interest in the interdependence of mental activity and social behavior in the positive influence exerted by each on the other and research directed along these lines should prove exceedingly valuable. The present paper is but a preliminary step and endeavors to give only raw results showing growth in social behavior and mental activity after six months in nursery school without, at this time, drawing conclusions as to their possible interdependence.

The following data gathered at the Vassar College Nursery School under the direction of Dr. Martha May Reynolds during the year 1933–1934 show the growth in social behavior and mental activity over a six months period in nursery school.

A two hours' observation of each of the 21 children (24 five minute records) was taken—one hour in the Fall during the first three weeks of nursery school and the other in the Spring, six months later. The chronological ages of the children (7 two-year olds, 7 three-year olds, 7 four-year olds) ranged from two years, 0 months to four years, nine months as of October 15, 1933, the midpoint of the first period of observation.

The observation record allowed for a notation of the activity engaged in, the vocalization, and any social contacts made *by* the subject or *to* the subject during the 5 minute observation of him. Records were timed to 10 seconds.

With the data on social contacts, a distinction was made between the amount of time in social contact (any

method used: simple regard, vocalization, direct physical contact, physical contact through materials, parallel activity, or coöperative activity) and the amount of time in *group* contact. A *group* contact was defined as two or more children functionally and spatially together, with some common underlying aim or interest though not necessarily of the overt type. This interrelationship had potentialities for coöperation within the group both along the road toward and in the attaining of the goal. There was a positive feeling among the members and acceptance of each by the others. Such a group may have had destructive aims as regards the rest of society, yet so long as similar aims and mutual interest and aid in attaining a goal were evident, these members were a *group*. Quantitative data as to the time spent in activity with materials and the time spent in *active and constructive* use of materials were available. Average attention spans for materials and for children were easily obtained from each record.

It was found that in the Fall, the subjects spent 41390″ of the 75600″ (maximum possible in the 12 five minute records for each subject) in social contact, *i.e.* 54.7 per cent of their free play time. By the Spring, this figure was raised to 66.9 per cent. Of greater interest, however, was the amount of time spent in *group* contact, accepting and accepted by others socially, one of the aims of nursery school education. This was 22040″ (29.2 per cent) in the Fall and 34940″ (46.2 per cent) in the Spring.

There was an increase from Fall to Spring both in the time spent in social contact and in the time spent in *group* contact. The proportionate success, however, in the maintenance of *group* contacts, *i.e.* the ratio of the amount of time in *group* contact to the amount of time in any social contact, was greater in the Spring than in the Fall, 69.1 per cent as against 53.2 per cent. For example, PG, spending but 760″ in social contact in the Fall, brought this figure up to 1370″ in the Spring—an increase of 610″. While in the Fall only 160″ were in *group* contact, in the Spring it was found that 980″ were in *group* contact—an increase of 820″. That is, increases in the amount of time spent in social contact and the amount of time spent in *group* contact were not proportional, the per cent of success in the Fall, 21.0 per cent, being raised by Spring to 71.5 per cent. In the case of GP, a 350″ rise in time spent in social contact from Fall to Spring was found while a 1430″ increase in time spent in *group* contact was found. Again the increase in *group* contact was proportionately much higher with the result that the per cent of success in social contacts, while 50.4 in the Fall, was 93.4 in the Spring.

Table 1 shows that these results were evident at each of the age levels.

Results of a former study (1) showed that contacts of the following pattern types—*Regard, Vocalization, and Coöperative Activity* (*i.e.* one which included as main elements in the contact, the items, Regard, Vocalization, and Coöperative Activity); *Regard, Vocalization, and Parallel Activity; Regard and Coöperative Activity;* and *Regard and Parallel Activity*—were almost certain to result in successful *group* contacts

while patterns of the following types—*Regard; Regard and Vocalization; Regard and Physical Contact; Regard, Vocalization, and Physical Contact*—were almost certain to result in failure to establish *group* contacts.

an increase in those found "successful" (B) from Fall to Spring. Learning of the techniques of social adjustment had evidently taken place. This was as true with the two-year olds as with the three- and four-year olds.

TABLE 1

Growth in social behavior activity from fall to spring

	2-YEAR OLDS		3-YEAR OLDS		4-YEAR OLDS	
	Fall	Spring	Fall	Spring	Fall	Spring
Per cent time in social contact	32.7	50.4	61.2	66.9	70.3	83.4
Per cent time in group contact	13.9	32.7	31.8	39.9	41.7	66.0
Per cent success in social contact	42.4	64.9	52.0	59.5	59.3	79.2

TABLE 2

Distribution of contacts among the eight pattern types

	TOTAL GROUP		2-YEAR OLDS		3-YEAR OLDS		4-YEAR OLDS	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
A. Types unsuccessful:								
Regard	431	354	134	87	157	156	140	111
Regard and vocalization	185	193	20	33	63	62	102	98
Regard and physical contact	104	75	45	47	40	20	19	8
Regard, vocalization and physical contact	28	19	4	8	10	5	14	6
Totals	748	641	203	175	270	243	275	223
B. Types successful:								
Regard and parallel activity	78	225	51	72	58	68	69	85
Regard and coöperative activity	13	16	2	1	4	7	7	8
Regard, vocalization, parallel activity	54	66	17	17	11	20	26	29
Regard, vocalization, coöperative activity	18	17	3	2	8	0	7	15
Totals	263	324	73	92	81	95	109	137

Table 2 shows the distribution of initiated contacts among the eight pattern types (mutually exclusive) in the Fall and in the Spring.

In general, for all age levels, there was a decrease in those pattern types found to be "unsuccessful" (A) and

Only 3 of the 21 subjects showed decreases in social adjustment from Fall to Spring. Analysis of the patterns of initiated contacts used by them showed that, in spite of the opportunity to learn by experience, in spite of the direct teaching, their

records showed increases in those pattern types found unsuccessful and decreases in those pattern types found successful. Further analysis of these individual cases would be necessary to explain this atypical result. This point will not be discussed here. Attention was now to be directed only to the fact that growth in successful social behavior was correlated directly with changes in types of contacts made and made unnecessary a great number of separate contacts.

Individual increases from Fall to Spring in the per cent of time in *group* contact, in the case of the other 18 subjects, varied from 4.8 per cent to 50.5 per cent.

Sociability indices (the number of other children contacted by each subject—summing direct and indirect observations) increased markedly from

TABLE 3

	BL, −36 PER CENT SOCIAL ADJUSTMENT		PS, +47 PER CENT SOCIAL ADJUSTMENT	
	Fall	Spring	Fall	Spring
A. Types unsuccessful				
Regard	15	16	25	9
Regard and vocalization	4	2	1	1
Regard and physical contact	8	15	4	0
Regard, vocalization and physical contact	1	1	0	1
Totals	28	34	30 *	11
B. Types successful				
Regard and parallel activity	7	5	13	18
Regard and coöperative activity	1	0	0	0
Regard, vocalization and parallel activity	1	0	2	4
Regard, vocalization and coöperative activity	0	0	0	0
Totals	9	5	15	22

—increases in those types found successful, decreases in those unsuccessful.

Table 3 gives the analysis of the patterns used by one subject who showed a 36 per cent drop in social adjustment from Fall to Spring and those used by another subject who showed a 47 per cent increase in social adjustment from Fall to Spring. It will be noted that the total number of contacts initiated by PS was less in the Spring than in the Fall. This was due to the fact that the contacts made, proving successful, were prolonged Fall to Spring. For the two-year olds, the average index was raised from 279.0 to 518.1; for the three-year olds, the average index was raised from 595.0 to 768.4; for the four-year olds, from 880.9 to 1158.4.

From Fall to Spring, it was found (1) that more time was spent in social contact and *group* contact; (2) that proportionately more time was spent in *group* contact; (3) that the redistribution of types of approach used showed increases in those successful and decreases in those unsuccessful,

i.e. evidence that techniques for successful social adjustment had been learned; and (4) that a greater number of children were contacted with resultant practice in adjustment to various types of children.

There arises the question of the relative importance of maturation and learning by experience in social behavior development. It is conceded that in all probability maturation might account primarily for growth in social behavior, *i.e.* in the per cent of free play time spent in social contact and the per cent of free play time spent in *group* contact, for the results found showed increases at the succeeding age levels (table 1). However, maturation alone did not seem to be wholly responsible for the greater proportionate success in the initiation and maintenance of *group* contacts. The two-year olds showed a greater increase from Fall to Spring in the per cent of success in the maintenance of *group* contacts than did the three's and even the four's—22.5 per cent as against 7.5 per cent and 19.9 per cent respectively. Furthermore the per cent of success in the Spring at the two-year level, when their average age was 2 years and 10 months, was greater than that of the three-year olds in the Fall, when their average age was 3 years and 7 months. It would seem that although maturation might set the limits to the extent of social activity, within those limits the proportionate success seemed to be dependent on the learning of the techniques of successful social behavior either by experience (indirect teaching) or through direct teaching. This learning seemed to be as possible and as profitable at the two- as at the four-year level.

In addition to the increase in social contacts by means of which techniques of social adjustment were learned, practised, and firmly established, there were found increases after six months in the *active* use of the materials and equipment provided by means of which constructive mental activity was stimulated.

Results showed that in the Fall, the per cent of free play time spent in activity with materials was 79.5 per cent (81.3, 72.3, and 83.8 respectively for the two-, three-, and four-year olds); in the Spring 85.6 per cent (90.8, 80.5, and 85.4 respectively), *i.e.* about four-fifths of the free play time. However, activity with materials did not necessarily imply that the subject was deriving the full benefit of the equipment. For this, there should be *active* use of such equipment.

Anne's passive sitting on a tricycle, watching the other children could not be rated as complete inactivity with materials though undoubtedly it was not *active and constructive* use of the materials (since Anne was already three years old) such as would afford her practice in learning the controls and skills necessary to ride a tricycle. Henry's random manipulation of cubes, engaging in no constructive activity with them, should be considered, at his advanced age level (three years and ten months), as activity with materials but not *active* use of them through which development in the ideational field might be stimulated.

It was found that in the Fall, 66.6 per cent of the time was spent in *active*

use of materials (65.7, 58.4, and 75.6 for the three age levels respectively) and in the Spring, 79.9 per cent (81.9, 75.1, and 82.7). Each age group, independent of their unequal starts in the Fall were stimulated to reach similar maximum levels, about 80 per cent. At each age level, the equipment on hand is peculiarly fitted for that age level so that the two-year olds reached the same maximum as did the four-year olds with respect to their own equipment. A rise in per cent from the two- to the four-year level was not found as might have occurred if only one set of materials were used for all age levels. The two's then, in all probability, would have been unable to make as widespread and profitable use of it as the fours.

Individual increases from Fall to Spring in the *active* use of the equipment varied from 1.1 per cent to 42.1 per cent.

In the Fall, of the 79.5 per cent time spent in activity with materials, 66.6 per cent was in *active* use of them; in the Spring, of the 85.6 per cent, 79.9 per cent. Though a small increase was found in the total amount of time spent in activity with materials, a proportionately larger per cent of this time was spent in *active* use of materials by means of which mental activity was stimulated and mental growth and development fostered.

The importance of attention span in social behavior and mental activity cannot be overly emphasized. It is believed that the attention span for materials and the length of social contacts (*i.e.* attention span for children) are interrelated but, at this point, it is difficult to say in just which way. The results gathered incidentally in this study (not primarily one on attention span) showed increases in attention span after six months in nursery school. Attention spans for materials and attention spans for children (*i.e.* length of social contacts) were studied separately. In the case of materials, at the two-year level, an average attention span of 81″ found in the Fall was increased to 116″ in the Spring; at the three-year level, the 130″ average found was increased to 165″; at the four-year level, the 134″ was increased to 140″. The attention spans for children, as judged by the average lengths of maintained contacts, increased in the six months interval at the two-year level from 33″ to 63″; at the three-year level, from 49″ to 69″; at the four-year level, from 59″ to 98″.

To summarize: Growth in social behavior and mental activity was noticed after six months in nursery school (1) in the greater amount of time spent in social contact and in *group* contact; (2) in the fact that there was learning of the techniques of social adjustment—the using to a greater extent those types of approach found to elicit successful contacts with the result that a proportionately greater number of contacts were *group* contacts in the Spring than in the Fall; (3) in the increase in the number of children contacted affording opportunity for adjustment to various types; (4) in the gains at all age levels in the per cent of time spent in general use and in *active* use of materials provided; (5) in the proportionately greater per cent of time spent in con-

structive use of equipment with resultant skills developed in the motor and ideational fields; and (6) in the increases in attention spans for materials and for children.

It seemed true that the limits for "any social activity" and "any mental activity" might be set by maturation. Yet, within these limits, the proportional increase in "successful social activity" and "constructive mental activity" was as great or greater at the two-year level than that at the three- and four. Furthermore, since the average two-year olds in the Spring (age then 2 years and 10 months) surpassed the performance of the average three-year olds in the Fall (age then 3 years and 7 months) in per cent "successful social behavior" and "constructive mental activity," the conclusion might be drawn that learning by experience carried relatively more weight than maturation in regard to growth in these two fields.

CONCLUSION

Results showed that attendance at the nursery school brought about increases in successful social behavior and constructive mental activity and attention span. This improvement was due in part to maturation and in part to learning by experience (indirect teaching), and direct teaching. The data seemed to show that although maturation might set the limits to the extent of social activity, the success of this social activity—*i.e.* the extent to which the subject found himself accepted into a group was dependent on the techniques used. Two-year olds did use techniques found to be "successful" and, whenever they did, were as successful in their social approaches as were four-year olds. Similarly, a maximum of constructive mental activity with materials and equipment was found at the two- as at the four-year level.

Would it not seem then that learning by experience (indirect teaching), and direct teaching should be considered as positive factors in the growth and development of the preschool child in the fields of social behavior and mental activity?

REFERENCE

(1) MALLAY, HELENA: A study of some of the techniques underlying the establishment of successful social contacts at the preschool level. *Journal of Genetic Psychology*, Dec. 1935.

Relaxation and Some Related Factors

An Exploratory Study Made in Five Nursery Units[1]

DOROTHY VAN ALSTYNE

DAILY programs in nursery schools have been built primarily on the assumption that we should satisfy the child's needs to be active, to eat, and to sleep. They have been based on a broad general knowledge of the young child's requirements and the experience of nursery school teachers. Only recently has an attempt been made to observe children more closely in group situations and to determine experimentally what might be the optimum conditions for meeting the young child's needs in the daily program of the nursery school.

The relaxation period especially has been a subject of much thought and discussion in the three nursery schools in which this study was undertaken. The teachers and directors were particularly interested in knowing what conditions seem favorable to successful relaxation in children of this age; which of the following factors or combinations of these factors might bring about the best conditions for relaxation: the amount of activity in which the child engaged on the playground or in the playroom, the amount of time spent in outdoor play, or the more immediate effect of music and story periods just preceding relaxation?

Stretching and relaxing exercises are given previous to each relaxation period during the early part of the school year until the children have acquired the habit of relaxing easily. These are renewed as necessary during the year. During the relaxation period the children are placed on a hard surface; *i.e.* on rugs on the floor and the room is darkened. A calm quiet atmosphere is maintained largely by means of the relaxation of the teacher herself. Children whose muscles are tensed are aided to release the tension. The teacher flexes their arms or legs or occasionally exerts a slight pressure as a hand is moved slowly across the surface of the muscles.

The present study grew out of a desire to know whether factors other than those included in the regular procedure might not also be important aids to relaxation. As the study grew, interdependence of other factors was indicated. What was the relation of the quality of the relaxation to the following: the amount of extraneous

[1] The writer wishes to express appreciation to Rose H. Alschuler, Director of the Nursery Schools where this study was made and to Advisors of the Behavior Research Fund who sponsored this study. Among the many persons who coöperated in this study thanks are especially due to Emily Osborne and Helen Oberndorf.

activity in the luncheon period, the approximate amount of food consumed, the time which the child took in going to sleep, and the time spent in sleep? What was the relation of all of these factors to the amount of activity in which the child engaged in the preceding two hours of free play? Were age or sex additional factors? In understanding factors basic to relaxation, are differences due to variations within the same individual more important than differences between individuals?

The only study which deals with the rest period in the nursery school was published in 1932 by Staples (9). No effect of a rest period on the length of nap or the time of falling asleep could be found.

Previous investigations have shown the possibility that sleep is related to the amount of morning activity, the amount of play outdoors, the time of falling asleep (8) and the influence of the adult in charge of the nap period (9). Others, however, have found no relation to the amount of outdoor or indoor play to the amount of noon food consumption (10) or to the presence of other children in the room (6). The physiological drive for sleep has been indicated as the most important influencing factor in one study (6). The amount of activity of young children has been found to show sex differentiations (1) and to be effected by the type of situation in which the child finds himself (4). The amount of outdoor versus indoor play seemed to have little relation to the noon food consumption in the only nursery school study in which it was investigated (10).

GENERAL PLAN OF THE EXPERIMENT

To determine the relationship of the various factors to be studied it was decided to observe the children in five groups for a period of two months (March and May, 1932). Observers were to describe the amount of activity, the quality of the relaxation, and the type of behavior at luncheon by using rating scales as a guide. The approximate amount of food consumed, the time required to go to sleep, and the length of the afternoon nap were also recorded. Music and story periods preceding relaxation were experimentally controlled by distributing them regularly among all groups in relation to type of morning and day of the week. This distribution was made in order to secure comparable data. The indoor and outdoor play periods were likewise distributed in a prescribed order so far as possible. Information was secured from the parents in regard to certain factors in the home program for the twenty-four hours preceding the observations at the nursery school. The children were observed in each program on corresponding days of the week. The official temperature of each morning was also noted.

The subjects studied

The children enrolled in three nursery schools and two junior kindergarten groups, who were present for at least four of the eight observation periods, were the subjects of this investigation. Sixty-five children, 31 boys and 34 girls were finally included in the data. Of the 65 children, 42 remained for the afternoon nap period. The majority of the 65 children were

three and four years of age, although the age range was from 2½ to 5½ years. Nearly all of these children had been enrolled in the schools since the previous September, and some had been members of the group for over a year and a half.

Whatever tendencies may be suggested in this study, they cannot be due to the fact that they represent one situation only, or to the fact that they are the result of the personality of one or two teachers. This study represents an experiment carried on in nursery schools representing different social and economic situations and having as subjects a fairly random sampling of nursery school population, at least before the Emergency Nursery Schools were started. Two of the five nursery units from which the subjects came were the Winnetka Public Schools and three in Chicago. One was the Parker Practice Nursery of Chicago Normal College and two were The Garden Apartments Nursery School for Negro Children.

DESCRIPTIONS OF THE METHODS USED

The rating scales

At the time this study was planned (1932) the rating scales evolved by Sweeney, Hejiman and Sholley (11) seemed to be most helpful in suggesting a possible device for judging activity and relaxation by the rating method. Goodenough's scale (1) also was found helpful in defining some of the gross movements more accurately. Revisions of former scales were made by the present author because of the difficulty of handling nine different scales at once.

A combination was made of all indoor play scales and of all out-door play scales. Only free play periods were observed. Since these periods were usually about two hours in length, each child was rated on his performance during the major portion of the morning.

The majority of the concrete descriptions of specific activities of which the rating scales were composed were redefined and augmented in the course of practice in their use. Specific activity was analyzed according to the approximate amount of movement of the hands, arms, legs, and body. The indoor and outdoor activity scales were made as comparable as possible in regard to the different degrees of children's activity as judged by amount of movement of different parts of the body. This was done purely on the basis of the judgment of the two observers who revised the rating scales, since a more objective means was lacking. This approximate equating of the two scales was made in order that the results might be combined to give a rating representing each child's total morning's activity, or so that the outdoor and indoor activity could be studied separately.

In addition to the Outdoor and Indoor Activity Scales the Relaxation Period and Luncheon Behavior Scales were devised in a similar manner. These scales are not included in this article but may be obtained from the author.

Correlations were calculated between the observations made by two observers A and B who made the judgments throughout the entire period in which the data were gathered. The correlations between the

observations of these two judges, rating independently, are high, ranging from +.82 in the case of Luncheon Behavior Scale to +.96 for the Relaxation Period Scale. The correlations for all scales combined was +.90.

Two inexperienced observers X and Y were given the rating scales and asked to make two complete days' observation, using all four scales. No further directions or explanations were given except the method of timing by 15 or 30 second intervals. The correlations of the ratings by Observers X and Y with those by each of the two practiced observers were high, ranging at lowest from +.63 for the Luncheon Behavior Scale to +.90 for the Outdoor Activity Scale.

These correlations with two additional observers may also be said to constitute the validity of the rating scales, according to Thurstone (12).

Method of observation

The rating scale judgments were made by using the method of time sampling units. In the case of the Activity and of the Relaxation Period Scales 15 seconds of observation was the time unit found to be the best basis for judgment, but 30 seconds seemed necessary for the Luncheon Behavior Scale. A stop watch was used, and the two observers made their independent judgments simultaneously on the same child, going from one child to the next until all of the group had been judged and then repeating the process.

Records of luncheon and nap. Records of the approximate amount of food consumed were made by the nursery school teachers as part of the regular routine of the school for the sake of studying individual cases and also for the collection of data for studies to be made by the Elizabeth McCormick Memorial Fund. Although estimates of the approximate amount eaten by the children were made by the teachers in regard to each serving, it was thought possible to secure only a rough measure for the purpose of this study since the servings in each of the groups were likely to vary somewhat with individual needs, different personnel, etc.

The children's records were divided into four sections: (A) Those in which the children ate no luncheon, (B) Those in which the children did not finish the complete meal served (including dessert), (C) Those in which the children ate all of the meal served to them, and (D) Those in which the children ate more than the meal first served to them. Because of the possibility of varying sizes of servings in the four groups, the trends in each group were studied separately as well as in combination.

The afternoon nap records were customarily taken for the same reasons as the food records. The teachers recorded the time the child lay down in his bed, the time at which the child went to sleep (as judged by closed eyes, cessation of movement and regular breathing) and the time at which the child awakened.

Indoor and outdoor play periods. Each of the five groups were observed for eight mornings, making a total of 40 mornings of observation. On 11 of these days the children played indoors all morning, on 15 days during

the two hour free play period they played half indoors and half outdoors and on 14 days they played outdoors all of the time observed.

Music and story periods preceding relaxation. Quiet story periods and active music periods of 15 to 20 minutes each preceding relaxation were distributed in a prearranged order so that each group would have approximately the same number and so that due attention would be paid to the division between indoor, indoor-outdoor, and outdoor mornings. In all of the groups together there were 20 story periods and 20 music periods preceding relaxation. Although the music period largely consisted of activity including rhythmical interpretations of music such as marching, skipping, galloping, etc., as well as singing, clapping hands to music, etc. quiet music was played at the end to make the transition before relaxation.

Type of previous home program. Since the influence of the happenings at home might have a marked effect on the quality of the child's relaxation or activity at school, it was thought interesting to see what could be discovered by considering this phase of the child's program. A questionnaire was accordingly sent home with each child and returned on the morning previous to the observation at the nursery school. The questions were designed to discover whether the child had had his usual program at home, or whether it had been an unusually exciting or stimulating one.

Days of the week. The observations were distributed to allow comparisons between the different days of the week. Each group was observed on five different days of the week during the two four-week periods in which the observations were made. Thus the final number of groups for each of the five days of the week was eight.

Outdoor temperature. The official temperature for ten o'clock for each morning on which the children played outdoors for part or all of the time was noted on each record.

Summary of factors related to relaxation

1. On the whole, the factors studied in the present investigation seemed to have little influence on the relaxation period.

2. When all cases are taken into consideration there is a slightly positive but an insignificant relation between the quality of the relaxation and

a. Amount of activity during the morning play period.
b. Location of play activities; *i.e.*, whether outdoor, indoor, or part indoor and part outdoor.
c. Nature of activities just preceding relaxation; *i.e.*, whether music or story.
d. A combination of the factors listed above under b and c. (Best combinations seemed to be an indoor-outdoor morning followed by stories and an outdoor morning followed by music.)
e. "Unusual" factors in the home program.
f. Extraneous activity at the lunch table.
g. Amount of food consumed.
h. Time of falling asleep.
i. Length of nap.
j. Day of the week. (Monday and Wednesday seemed poorer days for relaxation, Friday best.)
k. Temperature. (Warm weather records on outdoor mornings

yielded the better relaxation scores.)

1. Race. (Negroes scored better on relaxation than did whites.)

3. When only extreme cases were studied the following tendencies were noted: (a) The more active children tended to have poorer relaxation periods than the least active, (b) the children who had "external" disturbances in home programs, especially late bed times or illness in the household, relaxed more poorly than the others, (c) children who ate most at lunch tended to relax better than those who ate less, (d) the best relaxed children fell asleep on an average of 7 to 8 minutes sooner than the least relaxed, (e) the best relaxed children slept on an average of eighteen minutes longer than the poorly relaxed.

4. There was apparently no relation between degree of relaxation and age or sex.

Summary of factors related to activity

The findings of the present section indicate, in general, that individual differences are practically as great in the case of activity as they are in the case of relaxation, each within the limits of its own scale. The following tendencies have been noted for the cases as a whole.

There is a slight positive relation between activity in a free play period and location of play activities; amount of food consumed; day of the week; age; and sex. Children seem more active on the days they play outdoors than on indoor mornings or part outdoor part indoor mornings. The more active children tend to eat more. The less activity occurred on Monday and Friday, the most on Tuesday and Wednesday. The younger children were slightly more active than the older, and boys were slightly more active than girls.

There seemed to be little relation between activity in the free play period and temperature within the range studied; quality of relaxation; table behavior; and race.

An examination of extreme cases revealed the following trends: the extremely active took longer to relax than did the extremely inactive; the extremely active took longer to fall asleep and slept longer than did the extremely inactive; and a larger percentage of the most active children had disturbances in their home program.

Summary of factors related to nap

On the whole, the factors studied in the present section appeared to have little influence on the nap period. Individual differences and the factor of sleep habits established by this time of year would appear to be the more important. Among the tendencies which were noted, however, the following deserve mention.

In general, those cases who took longer to fall asleep tended to be children who spent part of the mornings indoors and part outdoors; who played outdoors in warm weather as opposed to cold weather; who ate more than the amount served; and who were observed on Wednesday as opposed to other days of the week.

Those cases who took the shortest time to fall asleep included children who played indoors all morning; who played outdoors on cold mornings; and who were observed on Friday as opposed to other days of the week.

Those cases who slept the shortest

time tended to be children who spent part of the morning indoors, part outdoors; who ate more than the amount served; and who were observed on Wednesdays as opposed to other days.

Those cases which were characterized by the longest sleeping time tended to include children who had played indoors; who had eaten less than the amount served; and who were observed on Tuesdays and Fridays as compared with other days.

When only the extreme cases were studied:

a. A positive relationship was found between length of time taken to fall asleep and high activity, poor relaxation, and an unusual home program.
b. A positive tendency was found for the children taking the least time to fall asleep to have good relaxation and low activity scores.
c. A positive tendency was found for the children sleeping the shortest time to be poor in relaxation and to exhibit a low degree of activity.
d. A positive tendency was found for children who slept longest to have high activity, extremely good relaxation, and an unusual home program.

The average length of the nap for the group as a whole was found to be 89.74. This finding is in close agreement with that of Sherman (8).

INTERPRETATION OF RESULTS

Significance of findings in the study of relaxation

Children in the nursery school at the time of year when this study was made had established habits of relaxation which were apparently little influenced by extraneous factors. No real differences in the degree of relaxation could be found under the varied conditions which were studied, although certain trends indicated the possibility of some slight effect of temperature on the mornings that the children played out of doors, the type of home program, and the day of the week. On the whole, however, the lack of effect or relation was more striking than the reverse.

The study has indicated that individual differences are important factors to consider when judging the quality of a child's relaxation. Through an analysis of individual differences it was found that a consistently high or low degree of activity and extremes in time of going to sleep and length of nap are related to the quality of relaxation. In other words, if good conditions for relaxation are provided and previous habits of relaxation have been established, the type of relaxation that will result would seem to depend more on the inherent qualities of the child than on factors in the daily program.

What the inherent basis of these individual differences is can only be a matter of conjecture, but there is a possibility that it is physiological. The nervous, glandular or nutritional constitution of the individual may be a determining factor in the degree of relaxation which he is likely to attain.

In addition to the constitutional make-up of the child, possible home disturbances constitute a factor to be considered. Although there was only a slight tendency for the children with unusual home programs to have a poor quality of relaxation, when the

factors in the unusual programs were analyzed it was indicated that the factors which are external, such as late bed-time and illness in the household, may have a relationship with relaxation at school. Contrary to the usual supposition, the factors in the program which have to do with variations in the child's own behavior such as temper tantrums and sleep disturbances seem to make little difference.

It is perhaps natural for temperature to show some indication of influencing the relaxation period. Heat is used by many physicians to aid in the lessening of tension in their patients who are subject to nervous disorders and a mildly warm bath is sometimes advised for its calming effect. It is possible that even greater differences in the quality of the relaxation period would have been found if the differences in temperatures studied had been greater.

The third factor which should be considered as having some significance in addition to individual variations is that of the day of the week. The tendency for the earlier part of the week to show poor relaxation periods and for Friday to yield a good quality of relaxation may be due to habits of relaxation gradually rebuilt during the week in the regular routine of the nursery school.

In the application of these results to the nursery school situation, it is apparent that there are certain factors which may have seemed important on casual observation but which further study reveals as insignificant for consideration in nursery school programs. The nursery school teacher who wishes to secure the best quality of relaxation for her children, once the habit of relaxation has been established as far as possible by means of the technique described, should feel more free, on the basis of the present study, to overlook a number of factors (such as amount of activity within moderate bounds, or type of activity—*i.e.* music or story period—preceding the relaxation period) and to concentrate on the more obvious factors of temperature, day of the week, and home program.

It is also extremely important for the nursery teacher to recognize the significance of individual differences. Is it, perhaps, a well-nigh physical impossibility for some children to attain the degree of relaxation of which others are capable? Is it possible that individuals who are hyper-active, characteristically disposed to take a long time to fall asleep, have a short nap period, or that those who have a different constitutional make-up may have difficulty in relaxing well? It is necessary for the teacher to decide definitely whether the child's restlessness is a conscious attempt to attract her attention or something which he cannot help before adopting any policy in the matter of inducing relaxation. The treatment would obviously be quite different in the two cases. If the child is seeking attention, the teacher would try to meet the situation with apparent unconcern or possibly isolation. If the restlessness seems unavoidable, it might be well to provide additional relaxation periods, both in the mid-morning at school and in the late afternoon at home.

Significance of findings in the study of children's activity during free play periods in the nursery school

Two trends noted in this section of the study are the tendency for the children when they played out of doors to be more active and for the more active children to consume more food than the inactive. The outdoor playground has large apparatus on which more active play can be performed than indoors, and the greater amount of space allows for more freedom of action. Likewise, the children who are more active are more likely to burn more body fuel and have larger appetites, as many nutritional studies have shown (7).

It was found that in the extreme instances, degree of activity was related to quality of relaxation, length of time taken to fall asleep and length of nap. When we consider the fact that the most active children tended to relax the most poorly, took longest to fall asleep, and tended to sleep longer than the extremely inactive children, there comes to mind the possibility of an underlying factor of nervous tension or other causes in the child's glandular, chemical, or nutritional constitution which may be at the basis of the high degree of activity. Perhaps this extreme activity is really undesirable and a symptom of underlying tension which makes it impossible for the child to relax well and to go to sleep quickly. Due to exhaustion, perhaps, the child sleeps a long time after he once falls to sleep. These assumptions, it should be noted, have only been suggested as possible explanations for the present findings. They are in need of further study.

The above suppositions seem to be somewhat substantiated when we examine the results of the study of home programs. A high degree of activity seems to be related to disturbed home programs, but whether the home programs are the cause of this disproportionate activity or are themselves symptoms of tensions and instability in the household would have to be studied in each case.

In interpreting the curves of activity in relation to the day of the week, one is reminded of similar results found in industry (2); *i.e.*, the lowered activity or "warming-up" period found on Monday, the highest peaks during the week when the workers have "gotten their stride" and the gradual slowing up toward the end of the week. In the case of nursery school children we might consider that the somewhat lowered activity on Monday would be due to the fatigue resulting from a probably different program on Sunday (including difference in time of meals, presence of extra adults, loss of nap or late bed hour), or to the readjustment to the school situation after two days at home. The lowered activity on Friday, coming after the higher level of Tuesday and Wednesday may indicate a somewhat calming effect of a week in the regular routine of the nursery school. The fact that the highest degree of activity is on Wednesday proves interesting in the light of the more frequent judgments by teachers of Wednesday as a "poor" day. The combined results of several other factors in the nursery school day such as relaxation, food consumption, and time of going to sleep also showed Wednesday to be the poorest

day. This relation of the greatest activity to the "worst day" may corroborate the theory that one of the underlying causes of extreme activity is tension. Why Wednesday should present this symptom more than any other day is a matter for conjecture.

It is not surprising that the younger children proved to be slightly the more active, as they are the ones who like the toys requiring more locomotion. Likewise, the older children are usually the ones who become interested for long periods indoors in the sedentary occupations of drawing, cutting, working with clay, etc., and who have a longer attention span in all activities (13). For practically the same reasons, we would expect the boys to be somewhat more active than the girls, a tendency which was also indicated in this study.

Significance of findings for the nap period

The differences between groups compared on the basis of factors studied in relation to the nap period are insignificant in comparison with individual differences. It seems apparent that at the time of year when this study was made the habits of falling asleep after a certain length of time and of sleeping for a certain period had been so established that other factors in the child's program could have little effect.

The same result has been indicated by other studies which have shown that children tend to sleep approximately the same length of time regardless of whether curtains are between their beds (5), whether they sleep in groups or alone (6), whether they have had a long outdoor play period, or whether they have had a rest period previous to luncheon (10). Sherman (8) also states that apparently children of this age acquire a habit of remaining in bed a certain length of time before falling asleep. The only study which showed any one factor as seeming to make a difference in the nap period was that by Staples (9), who found that the personality of the teacher in charge had some effect. The present investigation largely rules out this factor for the findings as a whole since there were four different groups who stayed for nap, each of which was in the charge of at least two teachers.

Careful training in the regular nursery school routine gradually builds up sleep habits and teachers in general expect children to sleep on the average a certain length of time once these habits have been established. Individual differences in time of falling asleep and length of nap are recognized here also as important aspects of the nap situation.

Certain tendencies in the findings of this study suggest that there may be some slight effect on the nap period, perhaps more at the time of establishing sleep habits than later, of such factors as temperature, day of the week, food consumption, and outdoor play, and in extreme cases, of activity of the child in the play period, the quality of his relaxation, and the type of home program. Although these tendencies are very small indeed, they may be found larger if more records are studied.

A study of the day of the week on which there were the worst and best

nap periods is interesting. On the poorest day, Wednesday, there was also the highest activity, poor relaxation, low food consumption. Why this is a poor day can only be surmised. Perhaps it is related to the high degree of activity found on that day. Tuesday as a good nap period may be so because by the second day of the school week the children have become once more adjusted to the school routine. Friday's good record can probably be explained by the gradual reestablishment of good sleep habits built up during the week.

As in the case of relaxation, it is seen that the child who is extremely active in the free play period and who has an unusual and probably "over-stimulated" program at home tends to take longest in falling asleep. Likewise, the most poorly relaxed child takes longest in falling asleep. As previously indicated in the discussion of the relaxation period, there is probably some underlying cause for this, whether of individual make-up or of instability in the home. Both may be present, but which is cause and which effect cannot be analyzed here. At least these findings point again to the marked differences between individuals which all nursery school teachers have learned to recognize.

Interrelation of all factors studied

When all of the types of situations studied in the nursery school program were analyzed for apparent relationships it was found that although children on the whole are not especially consistent in the apparently same situation there does tend to be more consistency in a child's reaction to a certain situation than there is in his behavior in a number of situations. The percentage of children who showed extreme instances more than once ranged from 35 to 70. For instance, if a child is extremely active on the playground on one day we can expect that he will be extremely active on some other day, but the fact that he is extremely active during his play period is no indication that he will be extraneously active and exhibit the best behavior at the lunch table or that he will not relax quickly or that he will take a long time to fall asleep.

Among the extreme cases, children who were best in one type of behavior situation were often worst in another, such as good relaxation and poor behavior at lunch, but children who were best in one type of behavior situation were seldom among the worst in that same situation and children who were in the poorest group were seldom found in the best. The greatest consistency in any one type is found in the length of nap and the least consistency in the degree of activity.

This trend toward consistency of extreme instances within one type of behavior situation and inconsistency among various situations points to the specificity of each of the types of behavior situations studied. In other words, not only is there a wide variety of individual differences but also a considerable variation in each individual's reaction to the type of behavior situation in which he finds himself.

REFERENCES

(1) GOODENOUGH, FLORENCE: Behavior in young children. Child Development, 1931, No. 1, 29–47.

(2) Industrial Research Department of the Harvard Business School in a forthcoming study to be published.

(3) JACOBSON, EDMUND: Progressive relaxation: A physiological and clinical investigation of muscular states and their significance in psychology and medical practice. Univ. of Chicago Press, Chicago, Ill., 1929, Pp. xiii, 428.

(4) KOCH, HELEN LOIS AND STREIT, HELEN: A study in rating technique with special reference to activity in pre-school children. J. Genet. Psychol., 1932, **41**, 330–335.

(5) MOORE, ELIZABETH: Study of factors influencing sleep in the pre-school. Unpublished study, Iowa Child Welfare Station, State University of Iowa 1929–1930.

(6) REYNOLDS, MARTHA MAY AND MALLAY, HELENA: The sleep of young children. J. Genet. Psychol., 1933, **43**, 322–351.

(7) SHERMAN, HENRY C.: Chemistry of food and nutrition. Rev. Ed., New York, MacMillan, 1932, Pp. 614.

(8) SHERMAN, MANDEL: The afternoon sleep of young children: Some influencing factors. J. Genet. Psychol., 1930, **38**, 114–126.

(9) STAPLES, RUTH: Some factors influencing the afternoon sleep of young children. J. Genet. Psych., 1932, **41**, No. 1, 222–28.

(10) STAPLES, RUTH AND ANDERSON, A. C.: A study of outdoor play, appetite, and afternoon sleep of young children. Child Development, 1933, **4**, 191–195.

(11) SWEENEY, MAY F., HEJINIAN, LUCEA M., AND SHOLLEY, REBECCA: A method for studying the activity of pre-school children. J. of Home Economics, 1929, **21**, No. 9, 671–678.

(12) THURSTONE, L. L.: The reliability and validity of tests. Edward Brothers, Inc., Ann Arbor, Michigan, 1932.

(13) VAN ALSTYNE, DOROTHY: Play behavior and choice of play materials of pre-school children. Behavior Research Fund Publication, University of Chicago Press, 1932, Pp. 108.

Author and Subject Index

ADOLESCENCE, physical growth in, 177
——, pubescence in, 177
——, research in, 285
Adolescent, personality of, 77
——, Rorschach norms for, 69
——, social world of, 285

BARUCH, DOROTHY W. and RISSER, JOSEPH C. An experiment with posture work in a nursery school. A preliminary report, 269
Behavior, social, 303
——, variation in, 56
——, verbal directions for, 196
BILLINGS, MARION LEROY. A report of a case of inverted writing and drawing, 161
Birth, accuracy of reports on, 165
Boys, developmental age of, 88
——, relative development of, 88
BRADBURY, DOROTHY E. and SKEELS, ESTHER LEECH. An analysis of the the literature dealing with nursery education, 227

CHILD development, problem of, 7
Child, memory span of, 110
Children, bilingual, 19
——, emotional responses of, 26
——, motor abilities in, 141
——, responses of, 52
Concepts, development of, 120
COWAN, EDWINA ABBOTT; MCCLELLAN, MERNERVA CHURCH; PRATT, BERTHA M. and SKAER, MAE. An adolescent personality schedule, 77
CRIDER, BLAKE. Unilateral sighting preference, 163
CUSHING, HAZEL M. and OLNEY, ELIZABETH E. A brief report of the responses of pre-school children to commercially available pictorial materials, 52

DATA, developmental, 165
Delinquency, indicators of, 154
——, juvenile, 154
DELMAN, LOUIS. The order of participation of limbs in responses to tactual stimulation of the newborn infant, 98
DENNIS, WAYNE. Laterality of function in early infancy under controlled developmental conditions, 242
Development, sex differences in, 205
——, skeletal, 205
DIMOCK, HEDLEY S. A research in adolescence, 177
DIMOCK, HEDLEY S. A research in adolescence. II The social world of the adolescent, 285
Directions, influence of, 196
Drawing, writing and, 161
DUREA, MERVIN A. Mental and social maturity in relation to certain indicators of the degree of juvenile delinquency, 154

EQUIPMENT, play, 56

FAMILY, food aversions in, 277
Feeding, problems in, 277
Fetus, response of, 253
FLORY, CHARLES D. Sex differences in skeletal development, 205
FLORY, CHARLES D. Predicting puberty, 1
Food, family aversions in, 277
FRANK, L. K. The problem of child development, 7
FURFEY, PAUL HANLY. A note on the relative developmental-age scores of urban and rural boys, 88

GOODENOUGH, FLORENCE L. and SMART, RUSSELL C. Interrelationships of motor abilities in young children, 141

HANDEDNESS, degrees of, 259
——, determination of, 91
——, variations in, 259
HERTZ, MARGUERITE R. Rorschach norms for an adolescent age-group, 69

INFANCY, laterality of function in, 242
Infant, tactual stimulation of, 98
Intermarriage, méntal deficiency and, 213

JOHNSON, MARGUERITE WILKER. The effect on behavior of variations in the amount of play equipments, 56
JOHNSON, MARGUERITE WILKER. The influence of verbal directions on behavior, 196

LATERALITY, developmental conditions and, 242
Literature, nursery education, 227

MACFARLANE, J. W.; STOLTZ, H. R. and PYLES, M. K. The accuracy of mothers' reports on birth and development data, 165
Magnitude, concepts of, 120
MALLAY, HELENA. Growth of social behavior and mental activity after six months in nursery school, 303
MALLAY, HELENA. The latent memory span of the pre-school child, 110
Materials, child's responses to, 52
Maturity, mental and social, 154
McCARTHY, DOROTHEA. Children's feeding problems in relation to the food aversions in the family, 277
McCLELLAN, MERNERVA CHURCH; COWAN, EDWINA ABBOTT; PRATT, BERTHA M. and SKAER, MAE. An adolescent personality schedule, 77
Memory, latent, 110
Mental deficiency, intermarriage and, 213
Motor abilities, interrelations of, 141
Movements, directions of, 26
——, emotional responses and, 26

NEONATE, activity of, 231
——, metabolic changes in, 231
New-born, responses of, 98
Norms, Rorschach, 69
Nursery education, literature of, 227
Nursery school, daily program in, 310
—— ——, growth in, 303
—— ——, posture work in, 269
—— ——, relaxation in, 310

OLNEY, ELIZABETH E. and CUSHING, HAZEL M. A brief report of the responses of pre-school children to commercially available pictorial materials, 52

PERSONALITY, adolescent, 77
——, schedule of, 77
Posture, nursery school and, 269
PRATT, BERTHA M.; SKAER, MAE; COWAN, EDWINA BOOTH; and McCLELLAN, MERNERVA CHURCH. An adolescent personality schedule, 77
Preference, sighting, 163
Puberty, prediction of, 1
PYLES, M. K.; STOLTZ, H. R.; and MACFARLANE, J. W. The accuracy of mothers' reports on birth and developmental data, 165

RAU, MARIAN R. Mental deficiency in relation to intermarriage, 213
Responses, pictorial materials and, 52
RICHARDS, T. W. Gross metabolic changes characteristic of the activity of the neonate, 231
RISSER, JOSEPH C. and BARUCH, DOROTHY W. An experiment with posture work in a nursery school. A preliminary report, 269
ROOS, MARY M. A study of some factors entering into the determination of handedness, 91
ROOS, MARY M. Variations with age in frequency distributions of degrees of handedness, 259

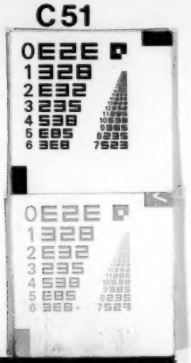
SCHRAMM, DOM GREGORY J. Direction of movements of children in emotional responses, 26
Sex, differences in, 205
Sighting, unilateral, 163
SKAER, MAE; PRATT, BERTHA M.; COWAN, EDWINA ABOTT; and McCLELLAN, MERNERVA CHURCH. An adolescent personality schedule, 77
SKEELS, ESTHER LEECH and BRADBURY, DOROTHY E. An analysis of the literature dealing with nursery education, 227
SMART, RUSSELL, C. and GOODENOUGH FLORENCE L. Interrelationships of motor abilities in young children, 141
SMITH, MADORAH E. A study of the speech of eight bilingual children of the same family, 19

SONTAG, LESTER WARREN and WALLACE, ROBERT F. The movement response of the human fetus to sound stimuli, 253
Sound, fetal response to, 253
Speech, study of, 19
STOLTZ, H. R.; PYLES, M. K. and MACFARLANE, J. W. The accuracy of mothers' reports on birth and development data, 165

THRUM, MARTHA E. The development of concepts of magnitude, 120

VAN ALSTYNE, DOROTHY. The relaxation period in the nursery school: A study of the interrelation of various aspects of the daily program, 310

WALLACE, ROBERT F. and SONTAG, LESTER WARREN. The movement response of the human fetus to sound stimuli, 253
Writing, inverted, 161


C51